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THE
LARYNGOSCOPE.

VOL. XXXVI OCTOBER, 1926 No. 10

ORIGINAL COMMUNICATIONS.

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ON THE CO-OPERATION AND INTERFERENCE OF REFLEXES FROM OTHER SENSE ORGANS WITH THOSE OF THE LABYRINTHS.

DR. R. MAGNUS, Utrecht, Holland.

It is not always that disease or loss of an organ leads to the development of symptoms. After loss of both eyes the patient is blind for the rest of his life and no mitigation or compensation is possible. But gastric achylia may be present without giving rise to any symptoms or with only slight disturbances, because the absence of pepsine in the stomach is more or less compensated for by the trypsine of the pancreatic juice and the erepsine of the intestine.

The labyrinths provide a similar example, and especially the otolithic maculae. These sense organs evoke different static reflexes. Other sense-organs evoke also static reflexes of approximately the same kind, and the different static functions of the body depend therefore not only upon labyrinthine, but also upon other stimuli. Whoever wishes to understand and to demonstrate the results of disease or loss of the labyrinths must therefore be acquainted with all other reflexes and mechanisms, which co-operate with the labyrinths.

These facts have hitherto received insufficient consideration in the clinic, although they are clearly demonstrated by experiments on animals. When I, therefore, received your kind invitation, which I believe to be a great honor for me and which gives me the opportunity of bringing before you some results of research carried out during the last seventeen years with the aid of many co-operators in my Utrecht laboratory, I thought it worth while to arrange these

*Presented at the joint meeting of the American Otological Society and the American Laryngological, Rhinological and Otological Society in Montreal, May, 1926.

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results from the point of view of the co-operation and interference of otolithic reflexes with those from other sense-organs.

The accompanying table gives a synopsis of the different labyrinthine reflexes as far as they have been investigated in mammals.

TABLE I.

LABYRINTHINE REFLEXES.

I. Reflexes responding to movements.

1. Rotatory reactions
   - a. on head
   - b. on eyes
   - c. on limbs
   - d. on trunk

   Apparatus of semicircular canals (Otolithic apparatus may also be stimulated by movements.)
2. Progression reactions.

II. Reflexes resulting from position.	**Otolithic apparatus.**
1. Attitudinal reflexes: Tonic labyrinthine reflexes on the body musculature.	
a. on limbs	Utricle.
b. on neck	Utricle.
2. Compensatory eye positions*.	
a. vertical	Saccule.
b. rotatory	?
3. Labyrinthine "righting" reflexes.	
a. asymmetrical	Saccule.
b. symmetrical	Utricule.

*) In rabbits and guinea pigs. In monkeys and man (a) and (b) must be exchanged.

CO-OPERATING REFLEXES.

Tonic neck reflexes.
on limbs

Tonic neck reflexes on eye muscles	**Rotatory reactions on eye muscles**
a. vertical	a. vertical
b. rotatory	b. rotatory
c. horizontal	c. horizontal

Body righting reflexes acting on	**Neck righting reflexes.**	**Optical righting reflexes.**
a. head		
b. body		

That a certain reflex is evoked by means of the labyrinths is proved by its disappearance after double labyrinthectomy. The reflexes from the ampullae of the semicircular canals are evoked by movements or more accurately by acceleration, whereas the reflexes from the otolithic organs depend on the position which the otolithic maculae have in relation to the horizontal plane. Otolithic reflexes, therefore, are reflexes of position and mostly of tonic character; this does not, however, exclude the possibility that the otolithic organs may also be stimulated by acceleration.

It has not been found possible up till now to extirpate in mammals the otolithic maculae or the ampullae of the canals alone and to leave the other half of the labyrinthine apparatus intact. The only

way to dissociate experimentally in mammals the function of these two parts of the vestibular organ was to centrifuge narcotised guinea pigs with high speed so that the otolithic membranes were detached from the maculae, while the cristae and cupulae remained intact. In each case at the end of such an experiment it must be demonstrable histologically that the cristae and cupulae are intact, that the maculae are completely freed from the weight of the otoliths, and that the otolithic membranes are found back in other places of the *endolymphatic* space. In successful experiments of this kind it could be demonstrated that, after centrifugation, the reflexes of Group I were present and undisturbed, whereas the reflexes of Group II were absent. The first group, therefore, depends on the canals, the second group on the otolithic maculae. The otolithic reflexes can be classified as:

1. Attitudinal reflexes.
2. Compensatory eye positions.
3. Labyrinthine righting reflexes.

I. ATTITUDINAL REFLEXES.

The body passes from one attitude into another by a change in the distribution of tone in its static muscles. It has been found that changes of this sort are most effectually evoked by changing the position of the head. With every position of the head corresponds a certain attitude of the whole body. These reflexes can best be studied in the decerebrate preparation, in which, according to the technic of Sherrington, the brain stem has been cut across through the midbrain at the level of the tentorium cerebelli. After this operation the animals perform no voluntary movement and show the well known decerebrate rigidity in which the static muscles have a highly increased tone, the tone of their antagonists being absent, or only slightly developed. The static muscles are the extensors of the limbs and the back, the elevators of neck and tail and the closing muscles of the jaw. Besides, in decerebrate preparations attitudinal reflexes can also be evoked in thalamus preparations (after the extirpation of the cerebrum in front of the thalami) and in intact mammals.

The attitudinal reflexes were found by chance during an experiment on a decerebrate cat of which the position on the operating table was changed and which showed strong tonic extension of the forelimbs. Repetition of the experiment on other cats revealed the fact that the different animals did not always react in the same way. A careful analysis was necessary and this showed that two sets of reflexes co-operate: tonic labyrinthine, and tonic neck reflexes, and

that the relative strength of these two sets of reflexes differ in various animals. The possibility of the co-operation of these two groups of reflexes becomes evident if we consider that by changing the position of the head we do two different things: *1.* We change the position of the head in relation to space and evoke thereby otolithic reactions. *2.* We change the position of the head in relation to the body and evoke tonic neck reflexes upon the body muscles.

In order to study the tonic neck reflexes alone, we must exclude the otolithic reflexes by extirpation of both labyrinths. After this operation the reactions to changes of position of the head become constant without individual variations. Ventri-flexion of the head in cats and dogs gives relaxatoin of the fore-limbs and extension of the hind-limbs. Dorsi-flexion o the head gives extension of the fore-limbs and relaxation of the hind-limbs. Rotation of the head gives extension of the "jaw-limbs" (the limbs towards which the jaw is rotated) and relaxation of the "skull-limbs" (the limbs towards which the vertex of the skull is rotated). Inclination of the head towards one shoulder gives also extension of the jaw-limbs and relaxation of the skull-limbs.

In these tonic reflexes of cats and dogs, therefore, one pair of limbs always react in the opposite sense from that of the other. Pressure on the lower part of the neck in a ventral direction causes relaxation of all four limbs (vertebra-prominens-reflex).

In order to study the tonic labyrinthine reflexes alone it is necessary to exclude the neck reflexes either by cutting the cervical posterior roots or by immobilizing by means of plaster the head, neck and thorax, so that only the fore-limbs can be freely moved and all neck movements are excluded. By bringing such a preparation into different positions in space one evokes changes of tone of all four limbs in the same direction. There is only one position in space in which the extensor tone of the limbs becomes maximal: The supine position of the animal with snout inclined a little above the horizontal. In that position, which differs from this by 180,° the tone of the extensor muscles shows a realtive minimum, whereas in all other positions in space, the tone is found to be intermediate between these extremes. The flexor muscles behave in a sense exactly opposite from that of the extensors, but show in the decerebrate preparation, at least, only slight changes.

Both the labyrinthine and neck reflexes are called tonic, because they last as long as the head is kept in a certain position.

In animals in which both sets of reflexes are active, co-operation takes place so that the tone of every muscle depends on the algebraic sum of the influences derived from the neck and from the

labyrinths, so that if the tone of a certain muscle be increased both from the neck and from the labyrinths a strong contraction results, and if the tone is decreased by the action of both reflexes the muscle relaxes; but if a muscle gets increased tone from the labyrinths and diminished tone from the neck, its state of contraction may remain unaltered if the individual animal happens to have labyrinthine and neck reflexes of equal strength. If the labyrinthine reflexes predominate, the muscle will in this experiment contract and if the neck reflexes are stronger it will relax.

If we put a decerebrate cat into the normal position on the table and flex the head in a ventral direction, the head comes into the position corresponding with minimal labyrinth reflexes, which will cause all four limbs to relax, whereas by the neck reflexes the fore-limbs are relaxed and the hind-limbs extended. In the fore-limbs, therefore, the two influences reinforce each other so that they show marked decrease of extensor tone, whereas on the hind-limbs both influences act in opposite directions, so that no change of position of the hind part of the body may result. Flexion of the head in a dorsal direction removes the head from the position of minimal labyrinth effect and this evokes increase of extensor tone in all four limbs. The neck reflexes cause at the same time extension of the fore-limbs and relaxation of the hind-limbs. Both influences cooperate in the fore-limbs, which will be strongly extended, whereas the hind-limbs may remain again unchanged. So it becomes evident, that raising or lowering of the head causes well marked changes of the forelimbs and no changes or much smaller ones of the hind-limbs. The same attitudinal influences can be seen in normal animals with the brain intact after active movements of the head, which very often by simple co-operation of otolithic and neck-reflexes cause very distinct changes of the attitude of the whole body.

Further analysis shows that one and the same movement of the head in relation to the body may set up various attitudinal reactions if the body takes various positions in space; *e. g.*, rotation of the head in the right lateral position causes strong reactions of the left fore-limb and in the left lateral position strong reactions of the right fore-limb; rotation of the head towards the right may in one position of the body give extension and in another give relaxation of the same limb. But in spite of all these complications it has been possible to explain all reactions found in a great number of experiments by the simple co-operation of those two sets of tonic reflexes.

Attitudinal reflexes are also present in man. Although in healthy adults under normal conditions they are only exceptionally demonstrable, they are found in a minority of normal babies and are

clearly to be seen under many pathological conditions. Both neck- and labyrinthine-reflexes have been found under various pathological conditions which affect the higher central functions. Of these the most striking are the tonic neck-reflexes evoked by rotating the head leading to an extension of the "jaw-arm" and "jaw-leg," with flexion of the "skull-arm" and "skull-leg." Tonic labyrinthine reflexes are rarer but have also been clearly demonstrated. In order to investigate them, all neck-reflexes must be excluded by fixing head, neck and thorax of the patient by bandages onto a moveable board, and also all reactions set up by movements must be excluded by waiting until these shortlasting reflexes have passed away; then if the same tonic reactions always correspond with the same orientation of the body in space from whatever direction this particular position is reached, we may assume them to be the result of otolithic reflexes working alone. This is further borne out by the observation that the tonic reaction persists as long as the position remains unchanged. In this way tonic labyrinthine reflexes which influence the extensor tone of both arms and both legs in the same sense could be demonstrated easily in several children, the clearest case being that of a child with amaurotic idiocy.

Dr. Walshe, of London, has shown, that if both neck and labyrinthine attitudinal reflexes are present, they co-operate according to the same laws as have been found in decerebrate mammals.

Attitudes shown by healthy people during ordinary life, as well as the attitudes of masterpieces of sculpture and painting give the impression of being natural and harmonious if they are in accordance with the laws of attitudinal reflexes, whereas attitudes opposed to these laws give the impression either of caricatures or of dead bodies. This is well seen in the case of wax models in shop window displays.

II. COMPENSATORY EYE POSITIONS.

The next group of reactions, in which otolithic reflexes co-operate with those from other sources, is concerned with the compensatory eye positions. These reflexes have the effect, that after changing the position of the head, the eyes change their position in the orbits in the opposite direction, so that the change of position of the head is partly or totally compensated for. The compensatory eye positions are imperfectly developed in animals in which the eyes have a frontal arrangement, and hence are so in man. The eye position is in such species mainly controlled by means of optical reflexes.

In mammals with laterally placed orbits, such as rabbits and guinea pigs, in which the visual fields only slightly overlap, it is impossible that one eye should exert optical control over the position of the

other. Therefore, another reflex mechanism becomes necessary, by which the position of the eyes in relation to the surroundings and to the orbit are regulated, when that of the head is changed, and by which also such co-operation of both eyes is effected as guarantees that the right and left halves of the visual world do not diverge.

Analysis has shown that this is accomplished by the co-operation of tonic labyrinthine and neck reflexes on the eye muscles.

In order to investigate these reactions it is necessary to exclude active eye movements and the influence of optical fixation. Fortunately in rabbits these happen to be practically absent, whereas monkeys for this purpose must be brought under narcosis. Further, one has to exclude all reactions evoked from the canals by waiting after every movement of the head until all rotatory reactions and nystagmus have ceased, and also by showing that the same eye deviation is always present if the same position of the head is reached from different directions.

In order to study the tonic labyrinthine (otolithic) reactions one has to exclude the tonic neck reflexes by fixing the animal (rabbit) on a board so that no movement of the head relative to the body is possible. This board, which carries also the photographic apparatus, can be orientated by means of its cardanic suspension in all directions in space. In this way it has been shown that the labyrinthine compensatory eye positions are the result of the co-operation of two reflexes:

a. Vertical deviations becoming maximal with the lateral position of the head, whereby the two eyes move within the orbits in the opposite direction; the lower eye is deviated dorsally, the upper one ventrally.

b. Rotary deviations in which both eyes always move in the same direction; the maximum rotation with the upper corneal pole towards the nose is seen if the head stands vertically with snout upwards, the maximum rotation in the opposite sense if the head stands vertically with snout downwards.

c. With regard to horizontal deviations no definite rules have been established.

In each different position of the head in space resulting eye position is the algebraic sum of the vertical and rotatory deviations evoked from the labyrinths.

Tonic neck reflexes in the eyes must be studied under conditions, by which all labyrinthine reactions are excluded. The safest way, therefore, is to extirpate both labyrinths. If this is impossible, then the head must be fixed and the body must be moved in relation to the immobile head. In this way a certain tonic influence from the

otoliths remains constant during the whole experiment, whereas the influences evoked from the neck receptors change and so become manifest. In this manner it has been shown, that by means of neck reflexes, verical, rotatory and horizontal eye deviations can be evoked.

Either group of reflexes, if acting alone, tends to compensate for changes in position of the head, but does not completely fulfill this task. If *e. g.*, the head makes a movement of 20° in a certain direction, the eyes change their position in the orbit in the opposite direction not by 20° but by much less, perhaps 10.° If on the other hand, both groups of reflexes are active, then the compensation becomes complete, as has been shown by A. De Kleyn. For this it is necessary that the animal should sit in the normal position and that the head movements should not exceed the normal range. Then changes in the position of the head will be completely compensated for by combined otolithic and neck reflexes with the effect that the visual fields remain the same and do not diverge, although the position of the head is changed. The precision of this finely adjusted mechanism is secured by still another auxilliary arrangement. Movement of the head from one position into the other entails not only a change of *position,* but also the act of *movement,* which itself stimulates the semicircular canals and evokes rotatory reactions of the eyes with nystagmus. The direction of these eye movements is such that the eyes are moved towards the new position, in which they will finally be kept by the combined action of otolithic and neck reflexes. The ampullar apparatus starts the movement, the otoliths and neck receptors finally fix the position attained. The result is that visual orientation in space without optical control becomes possible.

In man the optical control of the eye positions is by far the most important, and the compensatory eye positions have no great physiological significance, but notwithstanding this, both otolithic and neck reflexes are also present in man and may be used for diagnostic purposes. As the excursions are only small, a careful examination becomes necessary, in which all reflexes from other sources must be excluded.

1. In the first place optical fixation must be made impossible by giving the patient spectacles of +20 diopters (Bartels) or better by placing upon the cocainized cornea a round piece of tiny egg membrane, which is kept in position by simple adhesion and on which a cross has been painted with ink. If the patient is given a spectacle frame, on which a vertical and a horizontal wire has been soldered, all changes of eye position can be photographed and measured (De Kleyn and Versteegh) with exclusion of any optical fixation.

2. The patient must not perform any active eye movements.

3. Reflexes from the semicircular canals must be excluded by waiting after every movement of the head, until all transitory eye reactions and nystagmus have subsided, and by proving that the eye deviation appears if a certain position of the head is reached by movements from different directions.

4. In order to prove the presence of otolithic reflexes upon the eyes it is necessary to exclude all neck reflexes. Therefore, the relation of the head to the body must not be changed, and the whole patient must be investigated in erect, supine and lateral positions. In this way only can the otolithic reactions of the eyes be measured undisturbed by other reflexes.

By such methods rotatory reactions of the eyes have been demonstrated as pure otolithic by De Kleyn and Versteegh.

It has been shown long ago by Breuer, that dorsal and ventral flexion of the head with the erect position of the body evokes in blind patients distinct vertical eye deviations. It is probable, but not yet proven, that otolithic reflexes co-operate in this reaction.

5. In order to demonstrate tonic neck reflexes upon the eyes it is necessary to move the body in different directions with the head fixed. In this way the presence of rotatory, vertical and horizontal deviations has been demonstrated. This makes it clear how necessary it is to exclude the neck reflexes in every search for labyrinthine compensatory eye positions in man.

III. RIGHTING REFLEXES.

A third group of reflexes in which the otoliths co-operate with other sense organs in a complex function are the righting reflexes, by which the animal from every abnormal position in space is able actively to restore itself to a normal position. As mentioned above, the decerebrate animal has no righting function. It has been shown by Rademaker, that all sections of the brain stem behind the level of the red nucleus destroy the possibility of this active restoration of the normal position. On the other hand the thalmus and midbrain animals, in which the red nuclei have been left in functional connection with the spinal cord, possess the righting reflexes and, therefore, are able to sit, walk and jump exactly in the same way as an intact animal. It is essential in this connection, that the midbrain animal has no decerebrate rigidity, but a normal distribution of tone between static and flexor muscles; this also depends on the integrity of the red nucleus.

A decerebrate animal if placed on its side remains in this lateral position, whereas a midbrain—or thalmus—animal under these conditions immediately assumes a normal position.

Analysis has shown, that five groups of righting reflexes co-operate in this function. Of these, only one is of otolithic origin. It is, therefore, impossible to demonstrate the presence of labyrinthine righting reflexes by simple labyrinthectomy, because other groups of reflexes will provide for an apparently normal righting of the animal. In order to demonstrate the different righting reflexes it is necessary to start from a "zero condition" in which no righting reflexes at all are present.

For this purpose one must exclude:

1. Optical influences either by extirpation of the forebrain or by blindfolding or by using a species, in which optical righting reflexes are not developed, such as rabbits and guinea pigs.
2. Labyrinthine righting reflexes by labyrinth extirpation.
3. Every contact with the ground.

Under these conditions no righting reflexes are present. A delabyrinthized thalamus animal held freely in the air is completely disorientated and can be brought into every position without showing any correcting movement.

a. Labyrinthine righting reflexes.

If a thalamus animal with intact labyrinths is held by the pelvis in the air, the head is always brought into the normal position. If the pelvis is turned into the lateral position the head retains its normal position in relation to space. One can turn the pelvis from one lateral position into the other without changing the position of the head. If the animal is held with the head down, dorsiflexion of the neck brings the head into the normal position; if the pelvis is held supine, the animal either twists the whole body through 180° or makes a strong ventriflexion until the head stands again in the normal position. All these reflexes depend on the intact function of the otoliths and disappear after centrifuging away the otolithic membranes.

b. Body righting reflexes acting on the head.

A delabyrinthized thalamus animal kept in the lateral position in the air holds its head also in the lateral position. If placed in the lateral position on the table it immediately turns its head into the normal position. The cause of this is the asymmetric stimulation of the pressure sense organs of the body surface. This can be proved by compensating this unilateral influence by placing upon the upper side of the animal a heavy board. Then the head returns to the lateral position.

By the combined action of these two influences arising from the labyrinths and from the body surface the head is righted in relation to space and to the ground.

c. Neck righting reflexes.

When the animal is held in some abnormal position, then the righting of the head under the influence of the above reflexes entails flexion of the head or rotation of the neck, thus setting up a succession of reflexes, which gradually brings the body into symmetry with the head, until the whole animal is in the normal position.

d. Body righting reflexes acting upon the body.

These reflexes right the body in relation to the ground, independently from the position of the head. These reflexes can be demonstrated in the following way:

If an animal is held freely in the air in the lateral position, then the body shows no resistance against being held in this position. If the animal be now placed on a table, the body will immediately be righted into the normal position in spite of the head's being kept in the lateral position, and in spite also of the resulting neck righting reflexes, which tend to bring the body into symmetry with the head. The active stimuli arise from the pressure sense organs of one side of the body surface and can be thrown out of action by compensating this asymmetrical stimulation by placing a weighted board on the upper side of the body.

e. Optical righting reflexes.

The four groups of reflexes mentioned above are the only righting reflexes which have been found in the thalamus animal. Of animals with intact cerebrum, rabbits and guinea pigs are restricted to these reflexes only, but higher mammals, such as cats, dogs and monkeys, have a fifth set: the optical righting reflexes, which involve the cerebral cortex. A delabyrinthized dog or monkey held freely in the air in the lateral position, with its eyes covered, holds its head also in the lateral position. With open eyes, on the contrary, it fixes visually the objects in its environment and as a consequence brings the head into the normal position. As soon as this optical attention is no longer active, the head may go back into the lateral position.

In higher mammals with intact cerebrum there are, therefore, three groups of reflexes which right the *head:* otolithic, tactile and optical, and two reflexes righting the *body:* proprioceptive (from the neck) and tactile. The orientation takes place partly in relation to the ground, partly in relation to space. The multiplicity of the co-operating reflexes ensures that the function will not be lost even if one or more of the mechanisms be paralyzed. Labyrinthless animals can stand and move without great difficulty even with closed eyes. The trouble only becomes manifest if the animals are brought under water, where not only optical but also tactile orientation is impossible. Under these conditions labyrinthless animals are

completely disorientated and are in danger of being drowned. The same is true of human patients.

The study of the righting reflexes in man has just begun. We know only that the five groups described in animals are also present in human beings. The special use, and the limitation, of these reflexes in man as well as their development in children, forms the object of investigation by neurologists and pediatricians.

The presence of labyrinthine righting reflexes acting on the head has been demonstrated by Schaltenbrand in normal children for all positions in space; the eyes being blindfolded and the child held by the pelvis to exclude the optical and tactile righting reflexes.

Neck righting reflexes have been demonstrated by Landau in babies during the second half-year of their lives. In full grown patients neck righting reflexes have also been demonstrated (Zingerle). They are *certainly* also present in normal adults.

Optical righting reflexes are without doubt very active in man. This becomes evident in aviation, for here orientation is very difficult as soon as the aeroplane comes into mist or clouds.

Of very great importance are the body righting reflexes evoked by tactile stimuli. Our knowledge of these reactions is still very poor. Experiments of Garten and his pupils on an inclining chair show how very sensitive this mechanism is.

The relative importance of the righting reflexes in man at different periods of his life has still to be decided; also the manner of their co-operation to their special ends which is determined by the erect posture.

It is in any case evident that for a clear demonstration of otolithic righting reflexes all other righting reflexes must be carefully excluded.

From the foregoing it can be seen that it is not always a simple task to prove conclusively in man in normal and pathological cases that a certain reflex depends on the function of the labyrinths and that a certain symptom is the consequence of a lesion of the otolithic apparatus. The methods of clinical investigation in cases of otolithic diseases must be worked out in such a way that their results cannot be confused by reflexes from other sources. As it is to be expected that during the coming years many publications will appear dealing with real and pretended otolithic lesions it seemed worth while to direct attention to these difficulties.

Many of the cases of so-called otolithic disease, which have been published during the last years, cannot stand careful criticism and will probably be found to depend on quite other lesions.

How complicated things really are becomes evident if one tries to analyze the simple consequences of unilateral labyrinth extirpation in different species of mammals.

ABLATION EXPERIMENTS ON THE LABYRINTH OF FROGS.*

DR. JOHN TAIT, Montreal.

Mr. Chairman, Ladies and Gentlemen, I wish first of all to express my deep appreciation of the honor of being invited to address these two important Societies, the Otological and the "Triolog," an honor which for me is considerably enhanced by the fact of platform association with Professor Magnus, to whom and to whose fundamental work on the labyrinth we all take off our hat. In his charming "Tanglewood Tales," Nathaniel Hawthorne has retold the story of Theseus, who, sailing from Athens to Crete, slew the Minotaur in the great adventure of the Labyrinth. In view of his mastery over the intricacies of the labyrinth of the ear, we might well acclaim Professor Magnus as our Theseus.

You must have felt when you read the title of my particular address that you had come to a physiology department with a vengeance. If you want to see a physiologist really happy, give him a frog. If, however, you want to see an audience really bored, give them a physiologist to speak to them about a frog!

After all, the labyrinth is common to the whole group of vertebrates—fishes, amphibians, reptiles, birds, mammals from the lowest egg-laying platypus to the lord of creation himself. So that froggy is not in bad company. In the district where I spent my youth we had a local poet, who once astounded his friends by composing a poem on the liver. Someone asked what possessed him to write on such a subject, and he replied: "Ah! I searched through the whole of English literature and found that the great poets had written on all the organs of the human body except the liver; that is why I wrote my poem." It is noteworthy that physiologists, who have searched through and written upon all the organs of the body of the frog, have shown a marked disinclination to deal with its labyrinth, and for a very good reason. The frog's labyrinth is of such tiny dimensions and is withal so delicate, that had it not been for the conspicuous ability of Dr. McNally in carrying out the finest differential operations upon it, I should not have been talking to you today. Once these operative difficulties had been overcome, the frog proved to be a particularly valuable animal—superior in many

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respects to the customary fishes and birds—from which to deduce conclusions regarding the function of individual parts of the labyrinth.

In the labyrinth of the frog there are the usual parts—the saccular macula, the utricular macula and the three semicircular canals. Dr. McNally did operations on each of these parts, and I shall speak of them in succession. There is one point, however, which I must make quite clear; we did not pay any attention to the eyes or eye movements of the frog. Some of you, I have no doubt, will be relieved to hear this; others will be correspondingly depressed. My only hope is that the disappointment of the one party will be balanced by the satisfaction of the other. Our observations on disturbances of equilibrium concern only the limbs and body of the animal.

THE SACCULAR MACULA.

The illustration on the screen represents the saccular otolith and macula of the frog as displayed in a dissection by Dr. McNally. When one, or both, saccular otoliths is removed, or what is still more certain and conclusive, when the nerves to the saccular maculae are cut, the result so far as equilibrium is concerned is very clear and definite. The animal sits, crawls, jumps, swims absolutely in normal fashion. After any operation whatsoever on the saccular maculae we could not detect the slightest variation from normal behavior, and the animals, believe me, were elaborately tested. These wholly negative results are simply a confirmation of previous work both on fishes (by G. H. Parker and by S. S. Maxwell) and on frogs (by Laudenbach), which had gone to show that the saccular macula, at least of these lower forms, is not in any way concerned with equilibrium.

THE UTRICULAR MACULA.

I do not wish to dwell much longer on the utricular than on the saccular macula. I have no right to spend time upon it, firstly, because we have nothing new to report, secondly, because our operations on the utricular macula were in the end entirely accidental. The utricular macula happens to be particularly difficult of access and exposure, and we have no lantern illustrations even of the preserved and dissected organ to show. The nerve to the utricular macula is distributed very close to the two anterior ampullae of the semicircular canals, and either it or the macula itself is exceedingly apt to incur injury during operations on the canal ampullae. Any such accidental injury, even though uncontrolled, is, however, accompanied by uniquely characteristic symptoms, which show with the greatest clearness over what kind of reaction the utricular mac-

ula presides. The utricular macula is wholly an organ of *static equilibrium*, as has been recognized since the time of Breuer and substantiated very definitely by Professor Magnus and his school. I emphasize this, because there are still hesitant statements in the literature as to the respective parts played by the canals and by the utricular macula.

It is necessary to be quite clear as to what we mean by static equilibrium, and this involves a short but vital digression. On the table before me I have a rigid model constructed of three straight rods set at right angles to each other and intersecting at one common point. One rod points vertically; it represents the direction of gravity. The other two lie in the horizontal plane, one running north and south, the other east and west. The model represents the physicist's or mathematician's axes of reference in specifying displacements of a body. Now, if I take this oblong piece of board (on which we might allow a toy animal to stand with its body axis in the line of the board) and place it transversely across the N-S axis, both board and animal are still in the horizontal plane. So soon, however, as I rotate the board ever so slightly about this axis, the animal becomes tilted, either head downwards or tail downwards, as the case may be. If, without changing the direction of the (horizontal) board, I transfer it to the E-W axis and rotate about this axis, the animal is tilted either right-side down or left-side down, as the case may be. In other words, any rotation about a horizontal axis, whether this axis be N-S or E-W, tilts the animal out of the horizontal plane, the consequence being that it is apt to lose its balance and topple off. Yet see what happens if I cause the board to rotate slowly about the vertical axis! It remains horizontal, pointing now N-S or E-W or in any intermediate direction. Meantime the animal on the board also remains horizontal with no disturbance to its equilibrium whatsoever. There is therefore one axis, *viz.*, the vertical, rotation about which is of indifference so far as gravity is concerned. Rotation about this axis causes no tilting and no tendency on the part of the animal to topple over. When we come to think of it, we use the word "tilt" solely in reference to rotation about some horizontal axis. Only when the subjacent plane surface becomes tilted does the animal incur danger of upset.

When this surface is inclined or tilted out of the horizontal, the living, unlike the toy, animal *reacts* and adjusts its posture so as to be in stable equilibrium in spite of the new inclination of the surface. This reaction is purely a reaction against gravity, and the response is an automatic one, occurring just as well in the decerebrate as in the intact frog. The body of the animal becomes so placed as

to rest vertically above its four limbs. The head, too, tends to be held horizontal.

(Lantern slides were here shown representing stationary postures assumed by the frog on an inclined plane. In each case the head tends to be kept horizontal, while the center of gravity of the body is plumbed within the base of support formed by the four limbs.)

These stationary postures, which vary with the degree of inclination of the plane on which the frog rests, constitute reactions of static equilibrium. In taking up the appropriate pose the animal depends on nervous messages derived from four possible sources: *1*. pressure impulses due to contact with the ground; *2*. impulses from muscles and joints; *3*. impulses from the eyes; *4*. impulses from the utricular maculae. That these last impulses are of outstanding importance can be proved by the result of injury to the utricular nerves. When, in an otherwise almost intact animal, the macula is denervated on one side, the frog, notwithstanding the nervous messages from its eyes, from its muscles and from its palms and soles in contact with the ground, no longer squats naturally. On a horizontal surface it leans over to the operated side, its head and body having much the same relation to this surface as if the animal were intact and the surface had been tipped downwards on the nonoperated side. If both utricular maculae are denervated, the animal, when laid on its back, has great difficulty in righting itself. If it is blindfolded and thrown into water it loses all sense of the direction of gravity. This is why human patients with bilateral defect of the utricular maculae risk their lives if they dive into muddy water. When a mason or a carpenter wishes to place some structure in a vertical position, he uses a plumb-line. In the information they convey respecting the direction of gravity, the utricular maculae may be roughly compared with the plumb-line of the mason.

If we now glance backwards for a moment, we should make these statements with regard to the two otolithic organs of the labyrinth. So far as the body and limbs of the frog are concerned, the saccular macula has nothing to do with equilibrium. The utricular macula is the organ of static equilibrium, and is concerned in adopting and maintaining appropriate postures in response to gravity. Before we pass on, let me also repeat that any rotational shift of the horizontal substratum, whereby it remains throughout horizontal, is entirely neutral as regards these static postures. Only when the horizontal plane becomes tilted is a new posture assumed.

THE SEMICIRCULAR CANALS.

The semicircular canals—and it is to them that I wish to devote the main part of this lecture—are for *kinetic equilibrium*. Breuer

made the great distinction between *static* and what he called *dynamic* equilibrium. I am inclined to prefer the word "kinetic" to "dynamic," because in the end even static or simple gravity reactions are dynamic. But a mere difference of terminology is neither here nor there.

What exactly do we mean by kinetic as opposed to static equilibrium? If we consider plants as well as animals, we can readily understands the difference between the two. A plant or a tree grows vertically upwards in opposition to the force of gravity. Whether it is rooted on a plain or on the side of a sloping bank it uplifts and holds its stem in the vertical direction. In other words, it shows static equilibrium. Animals by contrast are motile creatures that run and skip about on legs. They turn and twist and yet maintain their balance. They frisk and jump, and, after springing into the air, land adroitly on their feet. These accomplishments are reactions of kinetic equilibrium, the static reactions being manifested only when the animal stands still.

Those of you who have visited the city of Edinburgh in Scotland may know that this town is ringed around with golf courses. You can almost walk around the city stepping from one golf course to another. The residents in one district of the city had selected for a new course a particularly precipitous part where the scenery is diversified with hills and dales and crags. At their opening ceremony they invited a celebrated professional of mature years and experience from a world-famous course to play the first round. When the game was over and the members had gathered in the clubhouse and handed in their scores, someone asked, "Well now, what is your verdict with regard to the general layout of our course?" The weary gentleman shrugged his shoulders and replied, "A'm a gowfer, no a bloody goat." The succinct remark was rather well phrased, because, if one considers for a moment, golf is really a game of static equilibrium, and so stands in sharp contrast with football, hockey, lacrosse, which are games of kinetic equilibrium. That is why contemptuous outsiders sometimes call golf a slow game, a game for grave and reverend signiors.

How do we proceed to test an animal for disturbance of kinetic equilibrium? If kinetic equilibrium is involved only during movement, it might seem at first sight a hard matter to make accurate observations. Yet the testing process is easy. The animal is allowed to sit still. All that is necessary is to jerk it about in an effort suddenly to upset it. A normal animal by prompt counter-reaction tends to maintain its balance. A decanalized animal is far less quick and is much more readily capsized.

On a number of occasions Dr. McNally succeeded in removing all six semicircular canals from a frog without other damage to the labyrinths. We had hoped today to show you one of these animals, and it is not his fault in any way that we cannot do so. This is the worst possible period of the year in which to operate on frogs. Just after the spawning season they succumb to operation and to sepsis much more readily than they do in winter. I have, however, a model here with which to show you the kind of effect. It consists of a piece of wood to represent the body of the animal. This is mounted on four spindly wire legs fixed into a wood base, like a toy horse. When I now weight the body with a piece of metal the sham animal still stands upright, and to this extent shows static equilibrium. When, however, I place the weighted model on a horizontal tilt-table and sharply tip the table through a small angle, the heavy body sways and rocks about. It is obviously wobbly on its legs, and that is exactly the impression given by a completely decanalized frog when subjected to some sudden displacement. A normal frog, as Dr. McNally will now show, behaves quite differently. (Demonstration.) No matter how quickly it is tilted from the horizontal its muscles are immediately innervated and it reacts so as to withstand the displacement. There is a promptness of reaction in the normal frog which is altogether absent in the decanalized animal.

Over its static equilibrium the decanalized frog has complete control. Set it on a tilt-table and incline the table ever so slowly. To each new angle of inclination it beautifully adjusts itself so that its body remains vertically over the base of support and its head is held horizontal. Its plumb-line mechanism is therefore working. But you must be careful at every stage to go slowly, for the utricular maculae and their connections are more deliberate in operation than the canals. So soon as we proceed to tilt quickly, the reflex static mechanism is found to be altogether too tardy, and the animal, lurching to the downward side, may lose its stability and topple off the table. Professor Magnus has already referred in his lecture to this interesting feature of canal function brought out in our experiments, whereby the intact animal, subjected to some sudden tilt, is on the cessation of the tilting movement already in the position that it is going to maintain under the uncomplicated influence of gravity.

This then is the first great characteristic of semicircular function, namely that appropriate responses are made—quick, rapid, almost lightning-like—so as immediately to counteract sudden tiltings and jerkings of whatsoever kind. The canals are called into action by something sudden; their effect is momentary and evanescent. The

plumb-line mechanism responds to a steady field of force; its action is sluggish but its effect is sustained. This is somewhat reminiscent of the difference between an induced and a constant electric current.

We now perhaps have a better conception of what is involved in canal function and kinetic equilibrium.

Differential Function of the Canals. As you know, there are six semicircular canals, three on each side, and it was one of Dr. McNally's achievements to effect clean and uncomplicated ablations of any single canal ampulla or of any combination of them. As a result we obtained a deeper insight into the function of the individual canals. As an experimental animal on which to determine the effect of these ablations, the frog proved to have quite peculiar qualifications. Let us stop, however, for a moment to explain how the canals sit in the head.

Each canal is a curved tube with a dilatation or ampulla at the end of it, in which in each case is situated the sensory organ and to which the sensory nerve is distributed. I have on the wall a classical diagram by J. R. Ewald, representing the position of the canals in the head of the pigeon. By painting the canals, as it were, on transparent sheets of glass, he has well represented the planes in which they lie. The matter can be made equally clear without a diagram, provided one uses one's arms to represent the canals, taking them in pairs at a time; by this method, too, the arrangement becomes more easy to remember. Let my bent arm represent the tube of the canal and let my closed fist represent the ampulla. Then if, curving both arms, I hold them out on a level in front of me, the fists about two feet apart, I am showing you the position of the *horizontal canals*, the ampullae of which, you will note, lie anteriorly. As the name implies, the horizontal canals lie in the horizontal plane.

Let me now illustrate the position of the two *anterior vertical canals*. Holding my arms out as before, I swing my elbows upwards. My fists, which are the ampullae of these canals, remain near where they were before, for the ampullae of the anterior vertical canals are close to those of the horizontal canals. The tubes of the vertical canals lie in vertical planes, and *note* how these tubes point. Not straight forward and parallel to each other, but forward and laterally in each case. Now if I swing my curved arms behind my back, keeping the curves, so far as may be, vertical, my fists, which in this case represent the ampullae of the *posterior vertical canals*, point backward and also laterally. In other words, the four vertical canals, lying in vertical planes, point towards the four corners of the body, and in each case the ampulla is at the outer extremity.

Differential diagnosis of lesions of the canals depends of course upon a knowledge of their individual function. At the present time there is one outstanding method, which we owe to Bárány. By an ingenious combination of his caloric test with rotation of the patient on his revolving chair, Bárány showed how it is possible to infer destruction or malfunction of particular canals. His caloric test, as you know, depends upon unequal distribution of temperature within the labyrinth. He cools the external ear passage and so produces a localized cold region of the bone inclosing the labyrinth. Meantime this bone is kept warm by the steady flow of blood from the internal carotid artery, which passes up like a hot stove-pipe beside it. The utricle is like a boiler, with which the tubes of the semicircular canals are connected, and, just as in a hot-water system a circulation can be established in the pipes connected with the boiler, the warm fluid mounting, the cold fluid descending, so Bárány was able, by turning the head now into this position, now into that, to bring any canal for the time being into a vertical position and thus stimulate it if normal and healthy. His method provides a beautiful proof that stimulation of the canals is due to movement of the endolymph within them, but in actual practice it is complicated and not wholly satisfactory. For one thing, he makes his observations on the eyes of the patient, and it takes experience to observe these with precision. For another thing—and Professor Magnus has dealt with this today—mere bending of the neck tends of itself to cause eye movements. In our work we left the eyes out of account. We found that by observation of limb movements it is possible, at least in the case of the frog, to diagnose quite simply an individual lesion of any of the four vertical canals. The method is capable of easy extension to human beings.

The Horizontal Canals. These are brought into action in rapid turning movements about a vertical axis.

Let me go back once more to this model of three rectilinear axes at right angles to each other. You remember that when an animal is rotated in the horizontal plane, *i. e.*, about a vertical axis, its static posture remains unaltered, for whether it points from north to south or from east to west, gravity acts upon it in similar fashion in each case. It is only when rotation occurs about a horizontal axis, in other words, when the horizontal plane itself is tilted, that new static postures are necessary. Why, then, should there be a pair of canals which respond to turning movements about a vertical axis?

Let me illustrate with a rather crude model. Here I have an animal with a body shaped somewhat like an hour-glass, a kind of

hybrid between a pig and a wasp. The body is made of a cylindrical cotton bag like a miniature pillow slip. Into the front end 4 inches of sand was poured and a ligature tied closely behind the sand. A second ligature was tied 2 or 3 inches farther back, then some more sand was introduced to represent the hinder part of the body, while a third ligature closed the end. The result is that there is a kind of swivel or flexible portion in the middle of the body. By means of cement the fore part is mounted on a piece of wood, which may represent the fore legs; the hinder part is mounted on a similar piece of wood to represent the hind legs. I place the animal on this horizontal turn-table, with the middle or flexible portion of its body over the vertical axis. If I turn the table gently the animal remains in stable equilibrium; it makes no difference whether it heads towards the south or towards the east; and when I stop turning, it stays as before. All this we have already discussed. Provided the turning is slow, the animal remains in secure equilibrium. But see what occurs when I grasp the spindle of the turn-table and make a quick turn of a quarter-circle in the direction of the sun. The animal falls, and observe what has happened. The fore part of its body has fallen over to the left side, the hind part has fallen over to its right! That is why the swivel was introduced into its makeup—in order to permit of torsion of the trunk. I repeat the experiment that you may see it again. You will now be prepared to admit that it makes quite a difference whether turning, even about a vertical axis, occurs slowly or rapidly.

Note how the animal lies. Its fore legs point towards its right side, its hind legs towards its left—and naturally so, because I pulled its fore legs from under it in one direction, and its hind legs (on the opposite side of the vertical axis) in the other. If I set the animal up again, consider for a moment what it ought to do with its fore legs if it should attempt to counteract the quick turn of the table in the direction of the sun. Obviously, as the ground moves from under it towards the right, it should step sideways with its fore limbs to the *left*. How should it step with its hind limbs? Obviously, sideways to the right! But if it steps to the left with its fore limbs and to the right with its hind limbs, it is performing a circus movement in the direction opposite to that of the turning of the turn-table. This is exactly what a real animal does when quickly rotated about a vertical axis to one or other side. It performs circus movements in the opposite direction to that of the turning, and these circus movements contribute towards better momentary equilibrium. The canals which are stimulated in these quick turnings about a vertical axis are the horizontal canals.

Dr. McNally has two frogs here, one a normal animal, one a frog in which he has destroyed the ampulla of the right horizontal canal. As he places the first frog on the turn-table and gives the spindle a quick quarter-circle twist in the direction of the sun, the frog makes an equivalent circus movement in the opposite sense. When he quickly twists the axis of the turn-table in the reverse direction, the frog as promptly moves against the direction of turning. When he turns the table quite slowly, the animal remains sitting still. The interesting experiment is now to come. How does the animal with the defect of the right horizontal canal behave? The table is twisted sharply in the direction against the sun, *i. e.*, towards the animal's left. The frog behaves normally and makes a short circus turn in the opposite direction. The table is now sharply turned towards the animal's right. No reaction. This proves that when the normal frog is quickly rotated towards its right it is the horizontal canal on that side that is stimulated. Had the lesion been effected, not on the right, but on the left side, the frog would have failed to respond when turned towards its left.

This result, so simple to remember, is not new. By operations on the horizontal canals of pigeons, Ewald long ago showed that rotation of the head to the right stimulates the right horizontal canal, and vice versa. At the same time, the frog experiments, being carried out on a wholly different class of vertebrates, give a wider basis to his deduction. As the conclusion holds true in respect both of birds and of amphibians, it may well apply also to mammals and man.

The Vertical Canals. From the previous exposition you will have already concluded that the vertical canals are brought into operation in rapid tilting movements about horizontal axes. Suppose I were asked to fix structures like the canals on a steamer, in order to signal disturbances due to wave movement. If I placed one pair in the fore-and-aft direction, they might signal the pitching movements. A pair in the transverse direction would signal the rolling movements. Why are our vertical canals not placed in this fashion, which would seem to be so simple and natural? For one thing, you must remember that the canals are not placed in a central position in the head, but in two laterally disposed, symmetrical groups of three; this introduces a complication with which as some of you know, Crum Brown signally wrestled in an acute paper of purely theoretical content. For another thing, we must keep in mind that an animal is no steamer. Land vertebrates walk on four struts or legs, and in the usual form of progression the body is supported alternately on pairs, consisting of right fore and left hind, and of

left fore and right hind, respectively. In each case the girder bridging the upper end of the limbs passes diagonally across the trunk, and the body may be said to swing in each case about a diagonal axis. Now, with respect to the vertical canals, the right anterior and the left posterior can be considered as constituting a parallel pair, while the left anterior and right posterior constitute another parallel pair.

As the vertical canals are arranged not anteroposteriorly and transversely, but as two diagonal pairs, the best way to orient an animal on the tilt-table in examining for defect of the vertical canals, is diagonally. Suppose we wish to test the left anterior and the right posterior pair. The animal is placed in such a way that this pair of canals lies at right angles to the axis of rotation; meantime the other pair, lying parallel to the axis of rotation, will not be stimulated. In order to be more exact in our specification, let us call one end of the tilt-table the front end and the other the back end; think of it as being the top of a two-wheeled cart, with the shafts to indicate the front. I place a toy dog diagonally on the horizontal cart. His head points to the right front corner, his tail to the left back corner of the cart. When he is so placed, which pair of canals will be stimulated by tilting movements? Obviously the left anterior and right posterior. I slowly depress the shafts. Will any member of the audience indicate on which of his limbs the dog's weight now mainly rests? Plainly, on the left fore limb. Suppose the tilting occurs suddenly, what should the animal forthwith do if he is to preserve his equilibrium? He should render this limb very firm and rigid, or even throw it farther away from the axis of rotation, *i. e.*, farther in the direction of the lefthand corner of his body. It will then best act as a strut to prevent toppling. This is exactly what a living intact animal does under the circumstances.

By raising the shafts I bring the dog back to the horizontal position, and now I tip the back of the cart downwards. His weight now falls mainly on his right hind limb. Should the tipping movement occur suddenly, a real dog would immediately stiffen this limb, or then throw it farther backwards and laterally, so as to meet the shock of the toppling body.

Now for Dr. McNally's demonstration of the effect of an actual experimental lesion. In the frog that he exhibits he has destroyed the ampulla of the right posterior vertical canal. He places the animal on the tilt-table exactly as I just placed my dog. The front end of the table is tipped quickly downwards. The frog easily preserves its balance. It would seem that absence of a posterior canal is of no consequence in a case of forward tipping. Now the

direction of tilting is to be reversed, and, please, observe closely. The animal, obviously taken unawares, rolls backwards over its limp right hind limb and falls off the table. The limb was not ready for its duty, which was to stiffen or extend and so to resist capsizing of the body. The experiment can be varied. Instead of placing the frog diagonally, Dr. McNally now sets it in the fore-and-aft direction, *i. e.*, with its body transverse to the axis of rotation. He tips the table backwards. The left hind limb is shot out backwards so as to save it against a fall, the right hind limb fails to move. On repetition of the experiment with a still sharper rate of tilting, the frog actually falls over backwards and to the right. You had just time to see that whereas the left hind limb was quickly and promptly extended, its partner on the right failed to move—whence the peculiar nature of the backward fall.

Numerous experiments of this kind, both on the anterior and on the posterior vertical canals, led us to the following interesting conclusion. Each vertical canal is especially associated with the limb of that quarter of the body towards which it points. A vertical canal is stimulated when the head is suddenly tipped downwards towards the quarter to which the canal points. The main effect of stimulation of a vertical canal is a sudden extension of its own particular limb, which is thrown diagonally away from the body, *i. e.*, further towards its own corner. In this way the limb is prepared to exert a thrust, *1.* upwards, against the weight of the falling body, *2.* horizontally, in the direction towards the center of the body. We may also note that whereas a vertical canal is specially associated with one particular limb, stimulation of a horizontal canal leads to movements of at least two and usually of all four limbs.

If we extend our survey over the animal kingdom, we find that semicircular canals are peculiar to vertebrates. An outstanding feature of vertebrate organization is the possession of four limbs. With these the four vertical canals are especially associated. We first meet with semicircular canals in the lowest fishes, or cyclostomes; these have four vertical but no horizontal canals. Only when we come to the true fishes do we meet with horizontal canals. If we may argue from this, we should say that the set of vertical canals is the more primitive and the more essential.

They guard and protect the land vertebrate against sudden falls due to stumbling or otherwise. When the land vertebrate eventually reaches the stage of raising himself up and walking on a single pair of limbs (cf. birds and man), his equilibrium is more unstable and the responsibility of the vertical canals greater than ever. Yet their essential mode of function is the same in man as in a frog.

We are walking along the road; our foot catches some obstacle; the body being momentarily held back, our head is smartly jerked downward and forward, just through the smallest angle. Before we have time to think our arms are shot out in front of us, and should we actually lose our balance, they are already in the proper position to save us. It is rare, however, during walking, to stumble straight forward. As a rule one falls somewhat towards the side on which the foot first gets caught. In such a case it is invariably the arm on that side that is thrown outwards, for the head has momentarily dipped towards that side. If we stumble backward and to some particular side, the head is made to jerk backward and to that side; as a result the leg on that side is violently and forcibly thrown backward and outward. A forward stumbling bird, *e. g.*, a young chick, throws its wing forward and with the help of resistance from the air saves itself. Indeed, the very act of violent forward propulsion of the arm of a man during a stumble, by counterreaction tends to check the initial rate of fall of his body. The whole question of kinetic balance becomes of consuming interest so soon as we begin to appreciate the function of the vertical canals.

Differential Diagnosis of Canal Lesions. We have seen that the canals fall into two groups, *1.* what we might call a ***nongravity*** set, which is concerned with waltzing movements, during which the body remains steadily at the same uniform level, moving neither up nor down; *2.* a *gravity set*, which is concerned in leaping and landing again on the ground, in protection against falls—generally speaking in movements in which the limb muscles are forcibly exerted in opposition to gravity. For differential diagnosis of lesions in the human subject involving one or other of these two sets, we might reasonably use two different forms of apparatus, just as we did in the case of the frog, *viz.*, *1.* a Bárány chair, rotating about a vertical axis, wherewith to test the nongravity set, *2.* some form of tilt-table, rotating about a horizontal axis, wherewith to test the gravity set. To meet the latter requirements we have designed and constructed a special table, which you see here alongside a Bárány chair. The two are complementary pieces of apparatus. They belong together but have separate uses.

Let me first of all make quite clear that we have carried out no elaborate simultaneous investigation with the two pieces of apparatus. Through the kindness of Dr. Birkett and of Miss Macleod, superintendent of the Mackay Institute for Deaf Mutes, we have had an opportunity of testing a limited number of deaf mutes. During a recent visit to Cleveland, Ohio, I was also privileged, thanks to

the courtesy of Dr. Ingersoll and Dr. Kendall, to test one or two other cases. I shall merely explain how the tests were carried out, leaving them to your experienced criticism. With a young patient from the Mackay Institute Dr. McNally will illustrate the mode of procedure, and you will be able to see for yourselves with what ease sudden tilting on the table brings out defect of the vertical canals.

First with regard to the Bárány chair. The only test that we have used—and this is not the conventional method—is to set the patient on the chair and, after blindfolding him, to rotate the chair through a small angle with varying degrees of angular acceleration. The patient is asked to indicate, by signing with the right hand or with the left hand, respectively, when he experiences rotation and the direction of this rotation. As Raymond Dodge has shown, an angular acceleration of 2° per second suffices to cause conscious sense of rotation in a normal person. A rate of acceleration below this does not excite the horizontal canals, to keep below which threshold one must take care to speed up very slowly indeed. Somewhere in the cerebral cortex there must be a region for conscious experience of rotation, including discrimination of the angular sign of that rotation. In Head's elaborate investigation on sensory localization in patients who had incurred brain injuries during the war, their reaction to rotation was unfortunately not investigated. It would be interesting to know where the center is.

In our limited experience, most deaf mutes on the Bárány chair have no trouble in detecting even a low rate of angular acceleration and in correctly indicating its direction. Occasionally, however, one finds a patient who shows obvious disability. His threshold is high: his answers are incorrect. We have examined two such patients, and both had acquired bilateral labyrinth trouble as a result of meningitis. These two patients, when tested on the tilt-table, showed behavior analogous to that of a completely decanalized frog. The other deaf mutes that we examined reacted on the tilt-table like normal individuals. Thus you will see that we have had no opportunity of making differential observations on single lesions of individual canals. The point of interest is that when we found a patient defective under the very simple test with the Bárány chair as just described, this same patient showed disability on the tilt-table.

Dr. McNally will now demonstrate the use of the tilt-table. As you will see, it has a broad square top. The patient is placed upon it resting on his hands and knees, and the breadth is to permit of his taking up any orientation, whether parallel to the sides or diagonal. A stout handle attached at one end—like the shafts of a cart

—gives leverage and protects against any sudden tipping of the unstable platform.*

First of all we demonstrate the behavior of a normal person. As he goes down on his knees he places his hands flat on the top of the table; he is not allowed to grip the sides. It matters not in which direction he is placed, anteroposterior, transverse or diagonal, his kinetic equilibrium during sudden jerks and throws of the table is perfect. (Demonstration.) Provided the angle of inclination is not made *too* steep, he is like a bird on a swaying branch and cannot be dislodged. The curious thing is that it costs him no effort and no attention. His balance is maintained by a wholly automatic process, and you will notice how his body immediately and invariably moves in a direction contrary to that of the tipping table. If any member of the audience imagines that this subject has had special training in tightrope feats, let him come down and be tested himself at the end of the lecture. It always gives a mild shock of surprise to discover with what ease and with what insouciance the appropriate movements are made. The thing simply happens, and the individual as such can take no credit for his unsuspected endowment. To one who might not care to be reminded of his quadruped ancestry, it is illuminating once in a while to experience the equilibrial unconcern of a dog or of an ape.

Let us now observe under similar conditions the patient who has suffered total loss of her canals. She takes her place on hands and knees, this time diagonally across the table, for it is in this position that we examine a particular pair of vertical canals. Were she to slew around through 90° and occupy the other diagonal, we should test the other pair of vertical canals. It does not matter how she holds her head, upright or looking downwards, provided merely that it is in line with the body. At each end of the table a guard is stationed beside her in case of a fall. (Demonstration.) You see the marked difference between the patient and a normal individual. When she is suddenly tilted forwards or backwards, even through an angle of, say, 10° or 15,° she is upset just as easily as if she rested on paralyzed limbs. Note, too, the swaying of the body even on the slightest tilt, and think of the model on spindly wire legs that I showed you some time ago. The resemblance, I think, is plain. You will understand why, in testing a patient, he should be asked not to grip the sides of the table. You can see that the patient is anxious under test. If left to follow her own devices she would

*The table will be described and illustrated in a separate communication. It is made by the mechanic to the Department of Physiology and Experimental Medicine, McGill University.

hold fast to the table-edge and stiffen her arms in the hope thereby of better resisting any unexpected movement. Indeed, such patients prefer if possible to hold on rigidly, and, like a man clinging to the swaying mast of a ship, to become for the time being a part of the moving system. Could anything better illustrate the beautiful responsiveness of the muscular mechanism under canal control than a comparative demonstration of this kind, the canals being intact in the first subject and obliterated in the second?

(I might mention that this young patient also suffers from utricular disorder, but that has nothing to do with her helplessness on the rapidly tilted table. If we ask her to stand on the table, facing in the direction of the axis, her feet somewhat apart, she can keep her balance during slow tilting, provided her eyes are open. If she is blindfolded she topples over when slowly tilted, whereas a normal person under similar circumstances keeps his balance.)

Conclusion. With this demonstration I conclude. We began with the frog, and we ended with the human being. I do not say that the labyrinth of the frog reacts in every way like our own labyrinth, or that experimental results obtained with this lowly vertebrate form can be forthwith applied to ourselves. One thing, however, you may be ready to grant, namely, that a case has been established for routine examination of patients with labyrinthine disorder by the double method of the Bárány chair and of the tilt-table. When further observations have accumulated, we shall really be in a position to decide whether lesions of individual canals in the human subject can by these means be as readily and as certainly diagnosed as they can in the frog.

(Additional details respecting equilibrium in relation to the labyrinth of frogs are contained in the following two papers: Tait and McNally: *Amer. Jour. Physiol.*, lxxv, 1925, 140-154. McNally and Tait: Ibidem, lxxv, 1925, 155-179.)

THE RELATION OF TACTILE IMPRESSION AND HEARING PERCEPTION.*

DR. MAX A. GOLDSTEIN, St. Louis.

If a closer association could be proven to exist between the sense of touch and the sense of hearing, some of the practical experiments that have been carried on within the past few years might be given a substantially scientific foundation and a wider range of usefulness.

John Tyndall, in his profound investigations of the physics of sound, observed more than forty years ago, that all of the special sensory organs—sight, hearing, taste and smell—

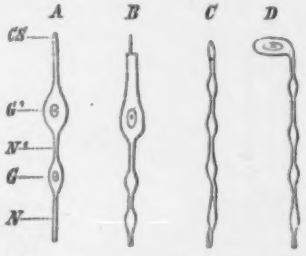

Fig. 1. *A*, peripheral nerve-ending, as seen in all the higher sensory nerves; *B*, rod-shaped end-cell of a sensory organ of the integument of a Fish or Amphibian, or a taste-cell; *C*, free, and *D*, ganglionated nerve-ending of the integumentary sensory organs of terrestrial Vertebrates; N,¹ first and N, second portion of the nerve-fibre in connection with the epithelial end-cell, G;¹ G, ganglion cell interposed between these portions; *CS*, cuticular process of end-cell. (All figures are diagrammatic; after Merkel.)

might justifiably be classified as modifications of the **Sense of Touch.** For this justification we may find sufficient evidence in a closer study of the embryology, comparative anatomy and physiology of animals, both vertebrate and invertebrate.

"The specific sensory end-organs originate, like the nervous system in general, from the epiblast. The peripheral terminations of the sensory nerves are thus always to be found in cells of epithelial origin, while mesoblastic elements are secondarily added to them."

"The individual sense-organs, *e. g.*, those of sight, smell, taste and hearing, are to be regarded as secondary dif-

*Presented at the Thirty-Second Annual Meeting of the American Laryngological, Rhinological and Otological Society at Montreal, June 1, 1926.

ferentiations of a diffused sense." In all vertebrates above the Cyclostomi the olfactory, optic and auditory organs are always closely connected with the head. They are enclosed within certain cavities and hollows of the skull designated as sense-capsules.

"In the higher organs of sense two kinds of cells are to be distinguished, although they are genetically identical with one another. The first of these are the proper rod-shaped **sensory cells**, connected by nerves with the central nervous system; the second are the **supporting cells**, which lie between the former and serve as a connecting and isolating material.

In all of the **higher sensory-organs** the medium surrounding the end-organs is **always moist**, and as this is also the case with

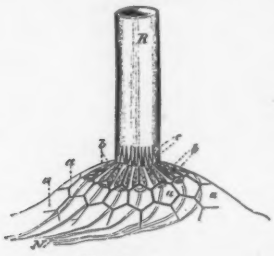

Fig. 2a.

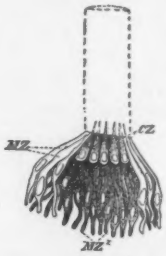

Fig. 2b.

Fig. 2a. Organ of the lateral line of a Urodele. Fig. 2b. Transverse section of a freely-projecting segmental sense-organ. The cuticular tube and the surrounding epidermic cells are removed. *CZ*, central (sensory) cells; *MZ*, *MZ*,¹ peripheral cells.

the Sensory-Organs of the integument of Fishes, we find to a certain extent similar nerve-endings in both.

In those animals which in the course of development give up an aquatic life and come on land, the surface epidermis layers dry up and the nerve end-organs pass inwards and undergo changes in form. The rod-shaped end-cells permanently disappear and two forms of nerve endings appear—**terminal ganglion cells** and **free nerve-endings.**

These segmental sense-organs always consist of a central mass of cells, arranged in the form of a round and depressed pyramid, and of a peripheral mass grouped around the former. The central cells are in connection with nerve-fibers; each of them bears at its free end a stiff cuticular hair and constitutes the proper **sensory cell**

Fig. 2b, CZ). The others (Fig. 2b, MZ, MZ^2) function only as a supporting mass.

In an analysis of the Sense-Organs in the integument of aquatic lower vertebrates it will be found in cases where these organs project freely from the epidermis that a delicate protective Hyaline tube is present and into this tube the terminal hairs of the sensory-cells project, and the tube opens distally into the surrounding water (Fig. 2a, R).

"In aquatic Amphibia these organs retain throughout life their peripheral free position, on a level with the epidermis; in Fishes they may, in post-embryonic time, become enclosed in grooves or complete canals, which are formed either by the epidermis alone, or, as more frequently occurs, by the scales and bones of the head, and open externally. The organs are thus protected and the hyaline tube is no longer found."

Fig 3. Distribution of the Lateral Sense-Organs in a Salamander Larva.

These Sensory-Organs are distributed over the whole body, but as a rule they are most abundant along certain tracts, the position of which is constant. They will be found in the head and in many instances extending backwards, these organs are arranged in metameric order and always connected with longitudinal nerves extending along the sides of the body to the caudal fin in one or more lateral lines, hence the term, Organs of the Lateral Lines.

Contra-distinguished from these **Segmental Sense-Organs**, as found in amphibians and fishes, we have the so-called **End-bulbs** in their many and various forms as found in the Reptiles, Birds and Mammals. From the amphibians upwards, they are found in the mouth cavity only, and not scattered irregularly over the head and body externally as in Fishes. Within these End-bulbs both central and peripheral cells, quite similar in character, are found, and they are especially exhibited in selective areas of the body. In amphibians they occur on the palate and on the fungiform papillae of the tongue; in mammals they are found on the soft palate, on the walls

of the pharynx, on the epiglottis and even extending to the larynx, but their most constant occurrence in the mammalia is on the tongue and in connection with the various types of papillae of the tongue (Fig. 8.).

"As regards the function of these sensory organs, it can only be affirmed that they must have to do with the perception of mechanical irritations from the surrounding water. In what manner the im-

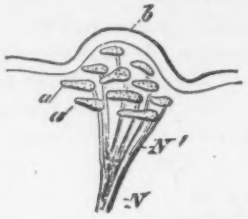

Fig. 4. A Tactile Spot from the skin of the Frog (modified from Merkel). *N*, nerve, which loses its medullary sheath at *N*;[1] *a*, *a*, neuro-epithelium; *b*, epidermis.

Fig. 5. Tactile Corpuscle from the tongue of a Bird. *N*, nerve; *H*, outer investment, with nuclei (*KH*); *S*, *S*, septa.

pulses give rise to perception cannot be definitely stated. In many cases they are thought to be concerned with the perception of sound, and we shall see that this is not improbable when we come to consider the auditory organ."

Beard has found that in embryos of the sheep and cow (8 to 10 m.m. long), the ganglia of the facial, glosso-pharyngeal and vagus nerves are fused with the epiblast, and thus indications of segmental sense-organs are still present, though they disappear or become modified later.

In these **End-bulbs** we find our first differentiation in tactile impressions as **Organs of Taste.**

Closely associated with the End-bulbs another form of terminal ganglion cells, known as Tactile Spots or groups of

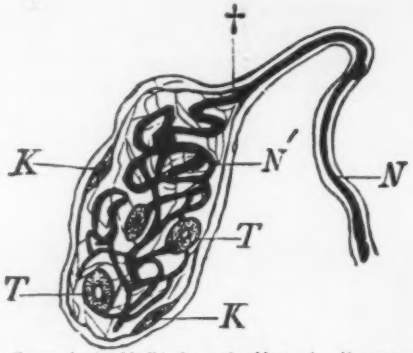

Fig. 6. Tactile Corpuscle (end-bulb) from the Mammal. *N*, nerve (the neurolemma of which at + becomes continuous with the investment of the tactile corpuscle; *K*, *K*, nuclei in the investment; *N*,¹ the coiled termination of the nerve (axis fiber) passing to the tactile ends (*T*, *T*).

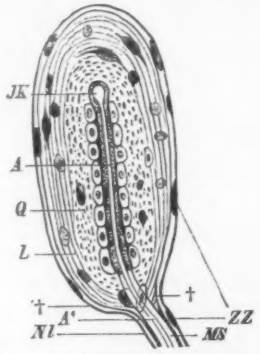

Fig. 7. A Pacinian Corpuscle from the beak of the Duck (after J. Carriere). *ZZ*, cells of the nerve-sheath; *L*, longitudinal, and *Q*, circular layers of the investing lamellae; *JK*, central knob, with the two pillars of cells; *A*, axis-fibre, with protoplasmic investment, entering the corpuscle at *A*;¹ *MS*, medullary sheath; *Nl*, neurilemma, which becomes continuous with the investment of the corpuscle at ++.

Tactile Cells, are found. These Tactile Spots are not necessarily on the surface of the epidermis, but are localized in selective areas. In Reptiles and Amphibians they are found in the region of

the head, on the lips and sides of the face and on the snout; in Birds the tactile cells are confined to the tongue and to the beak, forming tactile corpuscles. The tactile corpuscle is surrounded by a nucleated connective-tissue investment, from which septa extend into the interior, partially separating the individual tactile cells from one another. In Mammals the tactile cells are either isolated on the hairless portions of the body or occur as oval corpuscles of a many-layered and nucleated investment into which a nerve passes, becomes twisted up, and ends in one or more terminal ganglion cells."

Other forms of tactile corpuscles or touch-buds are found in the higher vertebrates and are designated as Pacinian corpuscles and corpuscles of Grandry: These varieties of corpuscles are all concerned with the sense of touch. The Pacinian corpuscle is found in the beak of Birds where it may develop a very highly sensitized tactile function; also found in the deeper layer of the derma of mammals and in various organs of the abdominal cavity.

Fig. 8a. Touch-bulbs in the hand of the Ape (Kollmann).

Fig. 8b. Touch-bulbs in the Human hand (after Hibert). *I*, first; *II*, second; *III*, third row.

"The olfactory organ, in its simplest form, consists of a paired, tapered, pit-like depression in the integument above the cleft of the mouth. A nerve passes to the base of this pit, and becoming enlarged in the form of a ganglion sends off nerves to the Sensory Cells, constituting the so-called **Olfactory Cells.** These must

be regarded as phylogenetic derivatives of the End-bulbs of that part of the integument which becomes pushed in to form the primitive olfactory pit (olfactory bulbs) and, therefore, comes under the same morphological category as the taste bulbs."

"The appearance of an **external nose** is very characteristic of the olfactory organ of Mammals; we must regard it as the outer chamber of the nose of Reptiles and Birds. It is formed by an extension outward of the nasal bones, and by a special cartilaginous support which arises from the ethmoid. The outer nose undergoes the most varied functional adaptations; it may give rise to a trunk-like organ, or even grow out to form a definite trunk, and by means

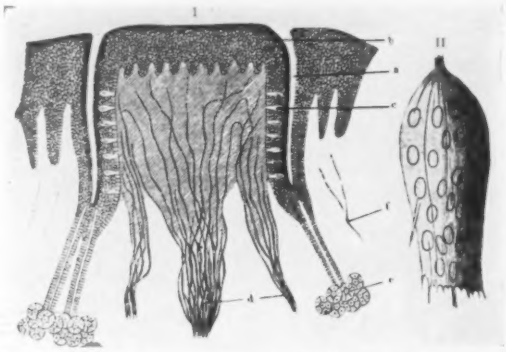

Fig. 9. Taste-organs in the Tongue (human). Highly magnified. (Thomé. *Zoologie.*) *I*, circumvallate papillae; *b*, vertical section; *a*, surrounding vallum; *e*, gland itself; *c*, taste-bud; *d*, and *f*, nerves. *II*, individual taste-bud.

of its abundant nerve supply, serve as a delicate organ of touch, and even as a prehensile apparatus."

The higher the scale of vertebrate development the more complicated is the organization of the Olfactory apparatus, and from the simple sac-like form as exhibited in fishes to the appearance of an external nose and the numerous spirals and twists of the turbinates of mammals, the nose assume a formidable function in conjunction with olfaction and respiration.

In the development of the **Eye** of vertebrates the sensitive elements (optic nerve and retina) arise from the primary optic vesicle. Structural cell arrangements are found in the retina similar to those of the neuro-epithelium of the taste and smell organs of vertebrates. The nerve-fibers of the retina alternate

with the rods and cones and bear much histological resemblance to the many and various peripheral nerve-endings in the sensory organ of the integument of fishes and amphibians, to the ciliated epithelial cells of the olfactory mucous membrane in mammals and to the ciliated auditory cells in the organ of Corti.

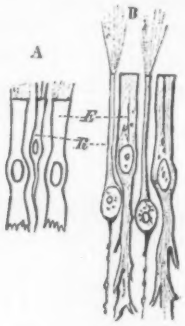

Fig. 10. Epithelium of the Olfactory Mucous Membrane. *A*, of *Petromyzon planeri*; *B*, of *Salamandra antra*. *R*, olfactory cells; *E*, interstitial epithelial cells.

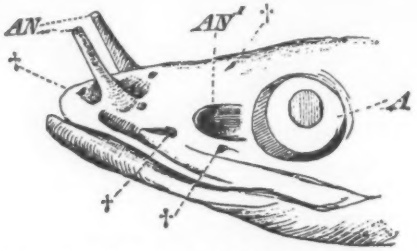

Fig. 11. Anterior portion of the head of *Polypterus*. *A*, eye; *AN*, *AN*,[1] anterior and posterior openings of the external nostril; +, +, +, apertures of the sensory tubes.

"It is very probable that the Auditory-Organ, like those of Smell and Taste, has been derived primitively from a modified integumentary Sense-Organ (the organ of the lateral line). The original embryologic form of both auditory and lateral line organs is a vesicle derived from the epiblast from which it later becomes separated off; it is lined by elongated cells of **sensory epithelium**, provided with hair-like processes (auditory hairs), and by **supporting cells.** Both structures are supplied by cranial nerves.

"Like the other higher Sense-Organs, the paired auditory organ of vertebrates is situated in the region of the head and always lies between the origins of the trigeminal and the vagus nerves. The first traces of it in the embryo are seen to the right and left of the hind brain and after the vesicle of each side has become separated off from the epiblast and connected with the auditory nerve which grows out towards it from the brain, it sinks deeper into the mesoblastic tissue of the skull; it then loses its original pyriform or rounded shape, and becomes divided into two parts, called respectively the utriculus and sacculus." From the utriculus the semicircular canals become differentiated; from the sacculus the recessus vestibuli (the aqueductus vestibuli or ductus endolymphaticus) and

Fig. 12. Scheme of layers of the Retina (Ranke). *a*, fibers of optic nerve; *b*, layer of ganglion cells; *c*, inner granular layer; *d*, inner nuclear layer; *e*, outer granular layer; *f*, outer nuclear layer; *g*, external limiting membrane; *h*, rods and cones.

the cochlea are formed. This whole, very complicated apparatus, constitutes the membranous auditory organ or membranous labyrinth.

"It becomes surrounded secondarily by mesoblastic tissue which is at first in close contact with it; later, however, a process of absorption takes place in the innermost layers of the mesoblast, thus giving rise to a space which closely resembles the form of the membranous labyrinth, as does also the mesoblast which encloses this space, and which later becomes chondrified and often also ossified. We thus get a membranous and a bony labyrinth and between them a cavity (cavum perilymphaticum) filled with a lymph-like fluid (perilymph). The cavity within the membranous labyrinth, which also contains a fluid (endolymph) is spoken of as the cavum endolymphaticum."

With the exception of the Cyclostomi (Lamprey) three semicircular canals are always present in vertebrate animals and always found in planes at right angles to one another. These canals arise from a vesicle-like swelling or ampulla associated with the utriculus, make their semicircular turn and again enter the utriculus. In the ampulla is the delicate histological element known as crista ampullaris; in the utriculus is the macula acustica; where a rudimentary cochlea exists extending from the sacculus a similar crista is found; finally, in the higher order of vertebrates we find the most complicated of the auditory sense-organs in the interior of the cochlea known as the papillary acustica or, as it is called in mammals, the organ of

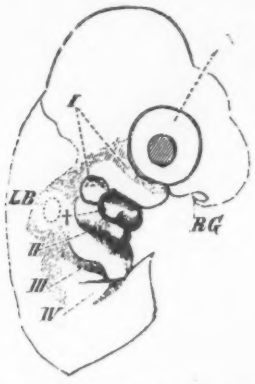

Fig. 13. Head and anterior portion of body of a Chick (in part after Moldenhauer). *RG*, olfactory pit; *A*, eye; *I* to *IV*, first to fourth visceral arches; +, point at which the external auditory passage begins to be formed; *LB*, primitive auditory vesicle seen through the wall of the head.

Corti, with its highly organized sensory-fibers arranged to perform an almost incomprehensible selective function in the analysis of the entire musical scale.

I have endeavored in this sketch to briefly outline embryologically and phylogenetically the relationship and gradual development of the general touch-sense to its most complicated mechanism of special sensory organs and especially to the auditory-organ in the mammalia and the human species.

There are many evidences of the development from a simple to a complex form of Sensory-Organs as traced through the various steps and groups of the classified animal kingdom.

The lower the classification of the animal in its anatomical, physiological and economic zoological rank, the simpler and more rudimentary are its Sensory-Organs; the higher it ranks in animal classification, the more highly organized and more definitely specialized are its Sensory-Organs.

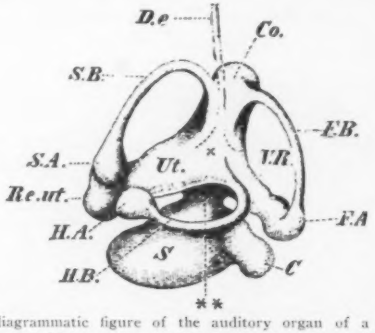

Fig. 14. Semidiagrammatic figure of the auditory organ of a Teleostean (modified from a figure of that of *Muroena anguilla* by C. Hasse). *Ut.*, utriculus; *Re.ut.*, recessus utriculi; *V.R.*, connecting-tube of the posterior ampulla (*F.A.*); **, wide conecting-duct between the pars superior and pars inferior; *S*, sacculus; *C*, cochlea; *S.B.*, *F.B.*, *H.B.*, anterior and posterior vertical and horizontal canals; *Co.*, canal commissure, with its apex; *S.A.*, *H.A.*, *F.A.*, ampullae of the anterior, horizontal and posterior canals; *D.e.*, ductus endo-lymphaticus.

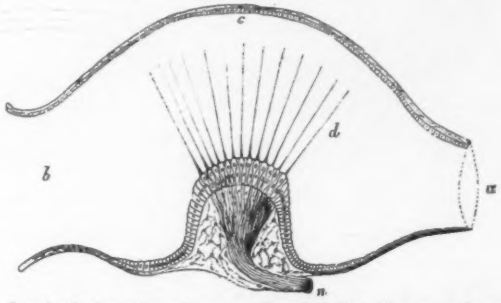

Fig. 15. Longitudinal section of an ampulla of Gobius (the exact form of the epithelium of the crista is not indicated) (after Hensen). *n*, the nerve passing into the connective-tissue of the crista; *a*, base of semicircular canal; *b*, point of opening of the ampulla into the alveus of the communis; *c*, the somewhat cylindrical epithelium on the free wall of the ampulla; *d*, the auditory hairs.

One of the most striking histological characteristics is the remarkable resemblance in structure of the various specialized Sensory-Organs:

The cilia of the central Sensory Cells in the organs of the lateral line of the salamander projecting into an external moist medium,—the coiled termination of the nerve axis fiber in the tactile corpuscle on the snout of a reptile,—the alternate rods and cones suspended from the external limiting membrane of the retina of the eye of an eagle,—the cili-

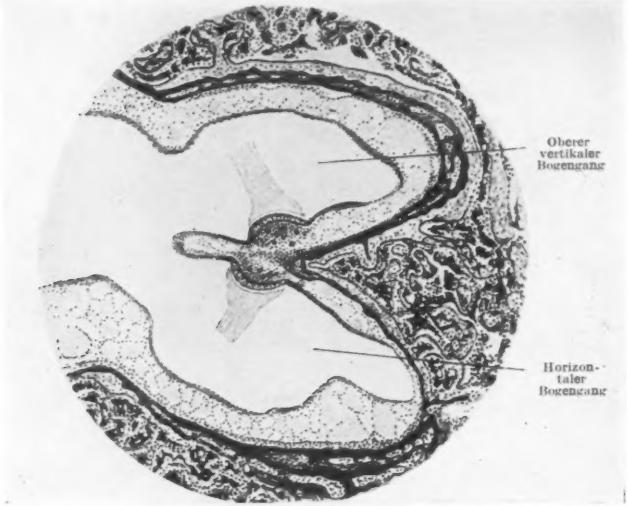

Fig. 16. Cristae ampullaris of the horizontal and vertical semicircular canals of Newborn Human, sectioned perpendicular to the base. Magnified 50x. Haematoxylin-Eosin specimen. (Eckert-Möbius.)

ated epithelium of the olfactory mucous membrane of the bloodhound,—the Deiter's cells with their terminal hairs of Hensen, suspended in the endolymph of the human ductus cochlearis,—all show a marvelous similarity in their delicate architecture, histological elements and minute functioning capacities.

Just as we speak mathematically of a greatest-common-divisor or least-common-multiple, or architecturally of a keystone in an arch,

or musically of a diatonic scale as a fundamental principle, so, too, it is our logical prerogative to associate all sensory impressions, whatever their nature might be, with a tactile end-organ. In the physical consideration of this subject we may also conclude that the origin of stimulation of a tactile impression must be a definite molecular force.

An auditory impression, then, is the reception of a wave of motion in a peripheral End-Organ of the Labyrinth, producing a tactile stimulation in a special Sensory-Cell apparatus and conveyed to the auditory cortical center in the brain as a Sensation of Hearing.

Fig. 17. Macula Utriculi of Adult Human. Vertical section, magnified 50x. Drawing of a Haematoxylin-Eosin stained specimen. (Eckert-Möbius.)

The statement has not yet been challenged that light, heat, sound and electricity are modifications of the same wave of motion varying in intensity, quality and direction. In many of our investigations and functional hearing-tests of both the normal and deaf subject it has been very difficult to determine where an auditory impression ceases and where a tactile impression begins, or to what degree one sensory impression may be translated into terms of the other.

In charting the results of audiometer tests we have been imperatively directed in the audiogram to a limited z o n e o f a u d i t i o n and, beyond that, to an a r e a o f t a c t i l e i m p r e s s i o n. As the result of my own research of the close association which has been found to exist between s o u n d and t o u c h impressions, I am not prepared to accept this arbitrary differentiation because all forms of functional tests thus far devised are inadequate to determine and analyze these finer perceptions.

Dependence on the sense of touch as a pedagogic substitute for the loss of an important special sense-organ is by no means a new

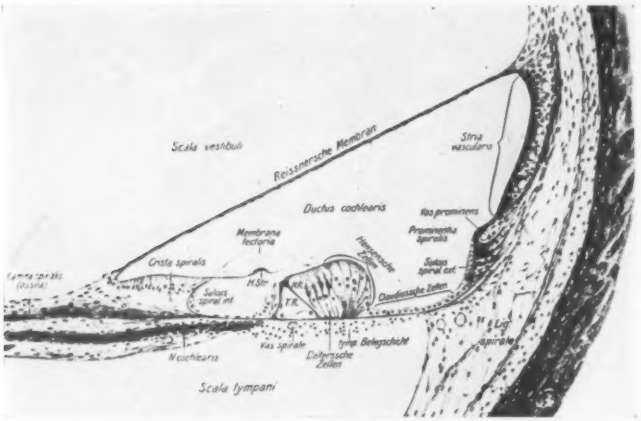

Fig. 18. Radial section of Ductus Cochlearis (human) of medial turn. Original drawing of specimen, fixed and stained with Haematoxylin-Eosin, according to Wittmack. *H.Str.*, Hensen striae; *N.R.*, Nuelsch space; *T.R.*, tunnel space.

thought. It has been used successfully by special educators in the instruction of the blind for many years; it is the basis for Braille reading, for Montisorri training, for various forms of sense-training in modern Kindergarten work, for Binet-Simon mental-status tests and for various psychological observations.

At a meeting of the National Association of Teachers of the Deaf, held at Mt. Airy, Pa., six years ago, a very creditable practical demonstration of a highly-sensitized touch-sense was given by a twenty-year-old blind-deaf girl, as demonstrated in the following experiment: The teacher (Miss Alcorn) rolled a hollow cylinder of foolscap paper, blocked the distal end with the palm of her hand and spoke in a normal conversational voice into the proximal end of

the cylinder. The pupil (Oma Simpson) touched the outside of the paper cylinder with her finger-tips and received, by tactile impression, the sound of the teacher's voice, repeating words, numbers and names with a fair degree of accuracy.

Prof. Robert H. Gault, of Northwestern University, trained a group of normal sophomore students to repeat a series of words received on the hand encased in a sound-proof box.

Last year I demonstrated before the Academy of Ophthalmology and Oto-Laryngology in Chicago, the New York Academy of Medi-

Fig. 19. Congenitally deaf pupil receiving and repeating spoken language as given by teacher through megaphone. Megaphone, covered at larger end by tightly stretched sheet of drawing-paper; finger-tips of pupil are placed on paper disc.

cine and the Philadelphia College of Physicians, a congenitally deaf pupil (Marie Tilson), whose finger-tips had become so highly sensitized that she was enabled, blindfolded, to receive and repeat entire sentences heard through an ordinary megaphone, the distal end of which was spanned by a tense diaphragm of Whatman paper and with which the tips of her fingers were in contact. These experiments have proven so scientifically fascinating and were developed so far beyond our original expectations that other deaf pupils were tested in similar manner and with satisfactory results.

It should be definitely emphasized that the success of these experiments and observations may be accounted for by the fact that our system of training the deaf child at Central Institute for the Deaf includes intensive work in sense-training, sound-vibration, voice-building, musical touch, rhythm and accent appreciation and a careful attention to the association of ideas in teaching oral speech, including

Fig. 20. Deaf child, blind-folded, being trained by Tactile Impressions to determine form, size and character of objects.

memory, form, color and other attributes that help to determine the psychology of language.

It is a significant observation that over 30 per cent of all congenitally deaf children have some residuum of hearing. In some cases it is of so limited a degree that it cannot be practically utilized; in a larger group it remains latent because of insufficient stimulation; in all cases it should be given a reasonably long try-out, for these auditory remnants are peculiarly sensitive to stimulation and re-

Fig. 21. Deaf pupil receiving first impression of sound-vibration by placing his hand on bones of face of teacher during latter's phonation of vowel and consonant elements.

Fig. 22. Class of deaf pupils holding finger-tips on sounding-board of piano acquiring rhythm, accent and pitch in music, through touch-sense, under guidance of teacher.

education and in a large percentage of cases the perseverence and resourcefulness of the teacher will be rewarded by surprisingly good practical results.

There is much promise in the use of apparatus embodying radio and telephone principles for the amplification of sound. An entire class of pupils with varying degrees of sound and voice perception can be taught simultaneously and daily. Fig. 23 illustrates such an apparatus. Each pupil has an independent adjustment of sound amplification to accommodate his individual case and all of the procedures of the acoustic method can be carried on with the

Fig. 23. Groups of deaf children in practice of acoustic method with sound-amplifying apparatus embodying principles of radio and telephone.

least strain and expenditure of time and energy. Since the introduction of such apparatus teachers in various schools conducting these observations assert that not only scholastic accomplishment is very much simplified and increased but that a distinct improvement in actual sound perception has been noted in many pupils.

How far we may be enabled to proceed with this substitution of one sense-impression for another and how much of it may be incorporated in a modern practical pedagogy for the training of the deaf child remains to be determined.

3858 Westminster Place.

THROMBOSIS OF THE LATERAL AND CAVERNOUS SINUSES, COMPLICATING ACUTE MASTOIDITIS: REPORT OF TWO CASES: ONE INVOLVING THE CAVERNOUS SINUS AS WELL AS THE LATERAL SINUS.*

DR. E. G. GILL, Roanoke, Va.

The achievements recorded in aural surgery during the past fifty years has kept pace, if not surpassed that of other surgical fields. While we are truly mindful and appreciative of these accomplishments, the fact remains that thrombosis of the lateral sinus following suppuration of the middle ear, either acute or chronic, constitutes a problem which at times taxes the skill and ingenuity of the most competent and experienced surgeon. During the past twenty-five years clinical data and mongraphs covering all phases of the subject have been written. These references are available to anyone, consequently a detailed study of the anatomy, pathology and symptomatology will not be given.

SYMPTOMS.

Emphasis should be given to the observations of many of the most experienced otologists in that there are no so-called typical symptoms. Each case is a law unto itself. Eves mentions the early appearance of the patient as being very deceptive. He looks well and feels well; later he will invariably show the anxiety and depression accompanying septic infection.

Edema over the posterior portions of the mastoid drained by the emissary vein is seen as an early symptom in many cases. It is described by Tobey as the most constant and reliable symptom.

Temperature: Elevation of temperature is one of the most common symptoms. Atkins reports elevation of temperature in 87.5 per cent of a series of forty cases.

Pulse: The pulse rate generally corresponds to the temperature curve.

Chills: True chills are present in less than 50 per cent of all cases.

Blood Count: Leucocytosis, a most common symptom and is present to some extent in most cases, average being from 14,000 to 20,000.

Bacteriology: Streptococcus occurs in the majority of cases. The streptococcus hemolyticus predominates in Eves' series of thirty-

*Read before the meeting of the American Triological Society, Montreal, May 31, 1926.

eight cases and Atkins' series of forty cases. Positive blood cultures are demonstrable in about 50 per cent of all cases.

A diagnosis of sinus thrombosis having been definitely established, the internal jugular vein should be either ligated or resected before opening the sinus. Rott in 1920 gave a very illuminating discussion concerning indications and contraindications of jugular ligations in sinus thrombosis. With this brief mention of some of the important symptoms and signs of sinus thrombosis, the writer wishes to report two case histories which present some very interesting features, particularly Case 2.

Case 1: M. P., male, child, age 9 years, was referred May 16, 1920. Gave a history of having had a right simple mastoid operation performed in 1917. Has had an occasional discharge from his ear since the operation. Present illness began May 13, 1920, with severe pain in his ear, which was followed by a profuse discharge. Examination of right ear: the canal was filled with thick foul-smelling pus and the posterior canal wall was sagging. Temperature was 104,° pulse 90, and respiration 25. A thorough, simple secondary mastoidectomy was performed May 17, 1920; a small area of the lateral sinus was exposed at the time of operation. The temperature, which previous to the operation was high and remittent, was not influenced by the operation. Culture from middle ear and mastoid showed pneumococcus type ii. Blood count on admission, May 16, 1920, was W. B. C. 11,000, polynuclear 80 per cent. May 19, 1920, a diagnosis of sinus thrombosis was made and operation was advised. Internal jugular vein was ligated. The lateral sinus was exposed throughout the entire mastoid process: on opening it a large clot was found and removed. Bleeding was obtained from each end of the sinus. Marked improvement following the second operation until the seventh day, when severe pain began in the right hip, soon followed by pain in left hip. This became a most distressing symptom and resulted in the diagnosis of bilateral tuberculosis of the hip. The mastoid wound healed promptly and has remained so after a period of six years.

Case 2: Child, age 11 years, referred by family physician Oct. 6, 1925. Five days prior to admission right ear began to discharge thick pus. The discharge increased each day. Pain in and behind ear and had been severe for five days. Past history negative except patient comes from neighborhood where there was an epidemic of typhoid fever. Several relatives in immediate vicinity recently died as a result of typhoid fever. On admission temperature was 103,° pulse 92, respiration 20. General examination negative, except septic appearance. Examination of right ear showed a thick purulent

discharge, marked sagging of canal and entire mastoid tender. Smear of pus from ear (right) showed pneumococcus infection. Left ear was normal. Functional examination of right ear: middle ear deafness, whisper 2 feet and labyrinth normal. Left ear normal. Blood count: W. B. C. was 17,000, and polynuclear 85 per cent. Operation: right simple mastoidectomy was performed. The bone was sclerosed. Pus was found in the mastoid tip and behind the knee of the sinus. Culture from middle ear and mastoid discharge was sterile, probably due to faulty technique. Temperature not influenced by operation. On the evening of the second day after the operation patient complained of being chilly. This condition was followed by a rise of temperature and pulse rate. Internists examined patient and reported that clinical symptoms were suggestive of typhoid. Widal was made and report was paratyphoid. Blood was negative for malaria. Blood culture was negative. Blood count, Oct. 8, 1925, W. B. C. was 17,700, and polynuclear 87 per cent. Condition was unchanged until the morning of the fourth day when patient complained of a chilly sensation, accompanied by rise in temperature and pulse rate. Blood count, W. B. C. was 11,700, and polynuclear 89 per cent. In the presence of a positive Widal and clinical symptoms of typhoid (abdominal distension, bloody stools) a definite diagnosis of sinus thrombosis was made. The internal jugular and facial veins were ligated. Bone covering sinus was very dense; after removing sinus plate from knee to bulb there was no evidence of the sinus wall, only a tract filled with pus of a most offensive odor. Culture was made and showed a streptococcus mucosus capsulatus infection. Bleeding was not obtained from either end of sinus. A small metal catheter shaped to conform to the torcular end of lateral sinus was introduced and suction applied, pus and particles of clot were evacuated. Same procedure applied to bulbar end, with like results. Bleeding was not obtained from either end. Temperature ranged for the four days between the first and second operation from 99.8° to 104.2.° It was not influenced by the jugular ligation. Patient's condition progressed unfavorably to a fatal termination on Oct. 16, 1925. Two days before death occurred exophthalmos of right eye was noted. This condition progressed rapidly, producing edema of lids, face and root of nose, conjunctival chemosis, dilatation of pupil and fixation of eyeball. Fundus examined but no changes observed. Autopsy was not permitted. The postoperative medical treatment in this case was directed by an internist. It consisted chiefly of intravenous administration of normal saline and glucose solution and the usual treatment for typhoid fever. Mercurochrome was used twice.

Comment: Both cases are illustrations of depleted physical conditions, which are a predisposing factor in sinus thrombosis following middle ear suppuration. Case 1, a tubercular patient; and Case 2, a typhoid patient. The exophthalmus of the right eye in Case 2 was unquestionably due to a thrombosis of the cavernous sinus. Time is not given for a complete differential diagnosis of septic cavernous sinus thrombosis from other pathological conditions, such as: injuries, neoplastic growths, orbital cellulitis, tenonitis, periostitis, panophthalmitis, nasal accessory sinus infection, exophthalmic goiter and tumors of the orbit, optic nerve and of the lacrymal gland. Each of these conditions were carefully studied and eliminated. The student who wishes further information of the differential diagnosis as well as the surgical anatomy, etiology, symptoms, diagnosis, prognosis, treatment and autopsy findings, will find these phases thoroughly discussed in theses by Dorland Smith, G. E. de Schweinits, Warren S. Reese, H. G. Langworthy, J. Julian Chisolm, Shelton Watkins and others. Cavernous sinus thrombosis is a comparatively rare condition. Dorland Smith, in 1918, prepared a thesis on this subject, reporting five cases and estimated that approximately three hundred cases are on record. From 50,000 surgical records of Johns Hopkins Hospital, from 1889 to 1919, only eight cases were found.

CONCLUSIONS.

1. Whenever lateral sinus infection is suspected complete blood examinations should be made daily. A sudden drop in the W. B. C. count with a rise of the polynuclears is significant. This was noted in Case 2.

2. Careful bacteriological studies should be made in every mastoid infection. A diagnosis of sinus infection, as Case 2, would probably have been made sooner had the character of the infection been determined immediately following the mastoid operation.

3. Sinus thrombosis occurs as a complication of both acute and chronic middle ear suppuration.

4. Early symptoms: elevation of temperature, with or without chills, headaches over side affected and edema and tenderness over area drained by mastoid emmissary.

5. In suspected cases when the laboratory and clinical symptoms are not conclusive, the sinus in the entire mastoid process should be uncovered and carefully examined.

6. When any case of lateral sinus thrombosis develops orbital symptoms, such as: exophthalmus, edema of lids, face and root of nose and conjunctival chemosis on the same side, septic thrombosis of the cavernous sinus should be suspected.

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711 S. Jefferson Street.

MOLT AND STORZ MODIFICATION OF THE TONSIL GUILLOTINE.

Dr. Wm. F. Molt, Indianapolis.

All who use the Sluder method of tonsil enucleation realize that the most satisfactory and complete enucleation can only be had by the use of a blunt bladed instrument. Such an instrument must of necessity have a perfect seating of the blade into the ring end of the guillotine in order to completely detach the connective tissue that holds the tonsil in its bed. Numerous appliances, mechanical dogs and double bladed instruments have been place on the market to accomplish this purpose, but in my hands none of these have proven satisfactory.

It is most annoying to say the least to attempt to enucleate the tonsil and find that the instrument fails to completely detach it, necessitating that the operator either tear off the remaining portion or cut it with a knife or scissors. Especially is this true when operating under local or gas anesthesia.

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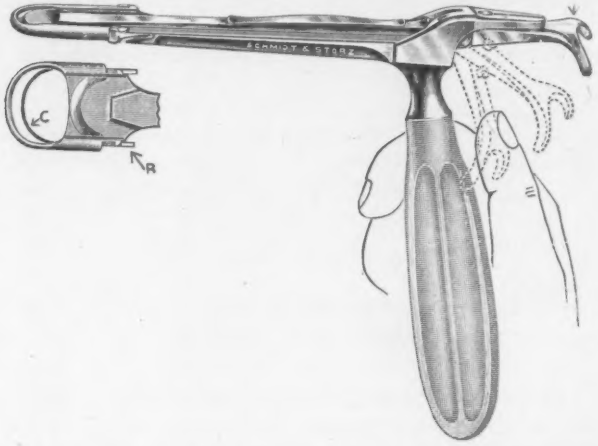
To overcome this we devised a flexible or resilient loop suspended on both sides of the fenestrated part, lying concealed and protected in the hollow ring end of the original guillotine. This resilient loop will, when pressure is exerted, adapt itself perfectly to the circumference of the blade, and by its use a complete enucleation can be depended upon.

As it is a mechanical impossibility to make a blade that will fit perfectly into a rigid ring instrument we therefore conceived the idea that a flexible steel loop could be placed into the ring end of the guillotine so that when the blunt blade was driven home by the special thumb dog, an even pressure would be exerted at all points of the blade and a complete enucleation obtained by the use of the



A, special thumb dog. B and C shows resilient loop partially removed.

thumb pressure alone. A special constructed lever which is a part of the blade itself makes it possible to exert all the pressure necessary with the thumb.

The blade and the carrier have been so constructed that this instrument takes up much less space in the mouth than the ordinary guillotine.

I have used this guillotine in a large number of tonsillectomies and so have a number of my associates, with perfect results. The instrument is made in two standard sizes, regular and large. They are manufactured by Schmid and Storz, Inc., Instrument Makers, 24 North Noble street, Indianapolis, Indiana. They may be obtained from any regular instrument dealers.

529 Bankers Trust Building.

SCIRRUS CARCINOMA OF THE THROAT.*

DR. WM. R. WATSON, Philadelphia.

Cancer and sarcoma of the throat and tonsil are frequently encountered; the sarcoma being found, roughly speaking, about three times as often as carcinoma. When cancer is found it is usually of the epitheliomatous or squamous cell type, with an occasional adenocarcinoma. Apparently, however, while comparatively common elsewhere in the body, notably in the female breast, scirrus carcinoma is unique, in that it is rarely found in the throat. I have covered the literature very thoroughly since 1893 until the present date without having found any report of a cancer in the throat of this type. Nor does Ewing in his book on neoplasms mention the existence of a tumor of this character either in the throat or tonsil.

The patient in this case is a young white woman, age 25 years, whose family history is uninteresting. Her personal history, with the exception that she had had her tonsils removed when she was age 15 years, is also unimportant.

History of present illness: Her chief complaint was a swelling in the right tonsillar region which interferes with swallowing and phonation. Patient states that when her tonsils were removed in the Philadelphia General Hospital ten years ago she drained pus from the right tonsillar fossa for some time following operation. She also states that she could see a small lump in her throat from the time that her tonsils and adenoids were removed, but that it had given her no trouble until lately, when it began to grow large. It had been growing progressively larger for a year, until now it may be felt in the neck, and interferes with breathing, swallowing and speaking. Hearing in the right ear is also impaired.

This young woman was admitted to the wards of the Episcopal Hospital on Sept. 25, 1925, and on giving the above history she was referred to the laryngological service for opinion.

On examination a hard nodular mass was seen externally, palpable below the angle of the jaw and inward almost to the midline. Intraorally a tumor was disclosed whose mass crowded the soft palate down to the left and so large as to almost fill the pharynx. The upper pole of the tumor reminded one of a very largely developed peritonsillar abscess, without the usual redness and edema. The surface of the tumor was smooth, covered by the anterior pillar and

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soft palate, and on palpation felt like hard rubber. By bimanual manipulation, with one hand externally and the fingers of the other pressing on the tumor within, the mass could be moved slightly from side to side, as if it were contained in a capsule. In other words, the opinion was formed—and correctly so, as it subsequently proved—that the tumor mass had not invaded the tissues outside of its own walls. The first natural thought was that it must necessarily be of a sarcomatous nature, although, personally, I could not accommodate my views entirely to this diagnosis, principally on account of the fact that it seemed to be encapsulated. All of the sarcomas of the throat with which I had come in contact had been fixed to the surrounding tissues. So, therefore, notwithstanding a history of lues was altogether lacking, this diagnosis was tentatively abandoned in favor of a gumma. Her Wassermann, however—three times repeated—was negative, and mixed treatment had no effect whatever in reducing the size of the tumor.

A biopsy was finally made, and on cutting into the tissue the knife slipped into a cavity, from which a bloody fluid escaped. This cavity was not large; perhaps about 1 c.m. in width and depth, and the tissue which was sent to the laboratory was gathered from within the latter by means of a biting forceps.

The report from the laboratory was as follows: "The tissue shows an inflammatory exudate of a polymorphonuclear type, with an increase of connective tissue. Beneath this there is some suspicion of a tumor of undetermined nature."

This report being so unsatisfactory, a second biopsy was determined upon, and a specimen was cut this time from the body of the tumor away from the cavity and in tissue that was very hard and resistant to a very sharp knife. But the report in this case was also disappointing. All that the laboratory was able to find was a mass of fibrous tissue, with some evidence of myxomatous degeneration.

An enucleation of the tumor was finally decided upon, and in contemplation of this an X-ray of the chest of the patient was taken for the purpose of determining whether any metastasis had occurred. The resulting opinion by Dr. Ralph Bromer is as follows: "Examination of the chest shows some slight peribronchial and hilum thickening, but otherwise no change. I do not think it shows any evidence of metastasis."

The tumor was removed on Feb. 3, 1926, and the operating notes on her chart read as follows:

"An Eves knife was introduced under the anterior pillar at the junction of the latter and the base of the tongue and an incision made along the edge of the pillar until the base of the uvula was

reached. This cleared the anterior pillar from the tumor. The tumor was then grasped with a tenaculum and pulled inward and downward, while, with a blunt dissector, the upper pole was delivered. The rest of the operation was done with the finger while making traction on the tumor with the tenaculum. There was a well defined line of cleavage, or a capsule—call it what you will—for the tumor was stripped down and out of its fossa with comparative ease, leaving the fossa clean of any remaining tumor."

The tumor as it was removed from its bed had the exact appearance of a fibroma so often seen shelled out of the body of the uterus, and measured approximately 5 by 5 by 3 c.m. There was one protuberance, almost pedunculated, which corresponded to the part of the tumor felt externally at the angle of the jaw, and described as a "hard and nodular mass."

Report of the histology of sections taken from the tumor by Dr. C. Y. White, Pathologist of the Episcopal Hospital, read as follows:

"Tissue taken from the tumor shows scirrus carcinoma with the cells running in indistinct cancer columns. In some part of the tumor there are greater masses of cells in pockets resembling a medullary type of tumor.

"The question arises as to whether this is cancer or sarcoma. From the description given above I believe that the type of cell is one of epithelium rather than of connective tissue type. The origin of such a tumor in the tonsillar tissue is of course difficult to state. The usual tumor of an epithelial character in this region is an epithelioma arising from the surface epithelium, or that which dips down in the crypts of the tonsil.

"The question of an alveolar sarcoma has been considered, with both hyaline and myxomatous degeneration, but the cell here found does not seem to correspond with the usual cells generally found in such tumors. In one section there is a tendency to glandular formation, so that such a tumor may have its origin in some of the epithelial structures in the vicinity of the tonsil."

With the idea of obtaining two opinions in the diagnosis of this case sections of the tumor were subsequently shown to Dr. Baldwin H. Lucke, Pathologist at the University of Pennsylvania, and he was inclined to concur in the diagnosis made by Dr. White.

After the operation and the diagnosis was determined upon the question arose as to the prognosis in this case. Dr. Astley P. C. Ashhurst examined the patient some time after she had recovered from the operation and declared that he could feel her submaxillary

and subparotid glands on the right and not on the left. On account of this he was rather pessimistic over her future. But when I reported the case at the staff meeting of the hospital last month, with the patient present, he failed to find the glands.

I am somewhat skeptical as to our ability of definitely stating whether an X-ray would show metastasis to the chest or not, and am therefore not overly sanguine as to the future nonrecurrence of the tumor in the chest of the patient, notwithstanding the hopeful report by Dr. Bromer. I can say with some assurance, however, that while it is somewhat early to expect it, there is at this date no evidence whatever of its recurrence in the throat.

2124 Pine Street.

INJECTION OF THE RECURRENT LARYNGEAL NERVE IN TUBERCULOSIS OF THE LARYNX.*

DR. HENRY P. SCHUGT, New York.

One of the most difficult tasks the laryngologist is called upon to meet is the treatment of tuberculosis of the larynx.

In the treatment of tuberculosis of a joint an attempt is made to cure the tuberculosis by putting the joint at rest. In a one-sided pulmonary tuberculosis artificial pneumothorax is induced in order to put the diseased lung at rest.

The same principle of immobilization may be applied to treatment of laryngeal tuberculosis.

I shall discuss a method which I have used in the treatment of unilateral tuberculosis of the larynx by immobilization of the affected side of the larynx, with apparently favorable results.

There are several well known methods for the immobilization of the larynx in the treatment of tuberculosis:

1. Silence treatment.
2. Tracheotomy.

Both methods might accomplish the desired result in a fairly satisfactory manner, but are objectionable, because the former is very difficult to carry out faithfully, and the latter is quite a severe operative procedure.

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The complete immobilization of the larynx for a considerable length of time without the unpleasant complications of a tracheotomy may be obtained by paralyzing the motor nerve of the larynx, *viz.*, the recurrent laryngeal nerve.

Leichsenring and von der Hütton were the first ones to produce surgically a one-sided paralysis of the larynx in the treatment of tuberculosis. Both have treated a large number of cases of tuberculosis of the larynx by unilateral resection of the recurrent laryngeal nerve. They made an incision similar to the one used in thyroid operations, exposed the nerve by lifting up the thyroid gland and either cut through the nerve or sprayed it with ethyl chlorid. As stated before, they aimed at putting half of the larynx at rest, as is done with the lung in pneumothorax, and thereby bringing about more rapid healing of the tuberculous focus. The cases especially considered in this connection are those having involvement of one vocal cord or ventricular band, or both on one side. Of course the resection of the recurrent nerve is a serious procedure and tuberculous patients should not, if possible, be subjected to major operations. Leichsenring, therefore, adopted a new and bloodless method by injecting the recurrent laryngeal nerve with alcohol and thereby paralyzing it.

I have treated at Sea View Hospital, Staten Island, fifteen patients suffering from laryngeal tuberculosis in this manner without having observed any complications, such as necrosis near the trachea.

The technic is simple. A needle 6 to 8 c.m. in length is pushed along the first tracheal ring to the vertebral column, then withdrawn 1 to 1½ c.m. and 1 to 1½ c.c. of 80 per cent alcohol injected. The paralysis lasts about eight weeks, more or less, when the muscles of the larynx resume their function. The advantage of this method, as compared with tracheotomy, consists in the fact that it does not weaken the patient and may be repeated if necessary. The strength of the alcohol has no influence on the duration of the paralysis.

My patients have been under observation for the past three to four months. All but two patients showed improvement of the condition of the larynx.

The following cases show very distinct changes of the larynx following the induction of artificial paralysis:

Case 1: A., pulmonary tuberculosis with cavitation.

Jan. 28, 1926, left vocal cord very much swollen and reddened.

Jan. 29, 1926, paralysis of left side of larynx induced.

At present the swelling and redness of the vocal cord are gone. Paralysis still persists.

Case 2: P., fibroinfiltration of the upper lobes.

Feb. 6, 1926, larynx: infiltration and ulceration of the right true vocal cord; marked swelling of the interarytenoid space. Left vocal cord moderately congested. Findings were stationary during five to six months.

Feb. 7, 1926, injection of alcohol into the right recurrent nerve.

April 6, 1926, return of mobility of the right vocal cord observed for the first time. It is still slightly congested, but the marked swelling and ulceration has disappeared. The swelling on the right side of the interarytenoid space is much reduced.

Believing that a paralysis of the left side might have a favorable influence on the swelling in the left half of the interarytenoid space, I have also induced paralysis of the left recurrent nerve.

Case 3: C. The patient during her stay in the hospital developed a tuberculous infiltration of the left processus vocalis, of the arytenoid and of the interarytenoid space, with considerable hoarseness.

One month after the induction of the paralysis the swelling of the processus vocalis and of the arytenoid disappeared. There is only a relatively slight infiltration of the posterior wall noticeable at present. A few days ago the left vocal cord regained its mobility. The voice is clear.

Case 4: F. The findings in this case were almost identical with those of Case 4.

The immobility of the larynx is not absolute if one wants to apply this method to such cases as have involvement of the arytenoid cartilage and the aryepiglottic folds, for in such cases these parts of the larynx are in passive motion and are irritated by particles of food being swallowed. In my opinion, in such cases a combination of paralysis of the recurrent laryngeal nerve and gastrostomy is advisable. It appears to me that the influence of the act of deglutition on the soft parts of the larynx plays a more important role in the etiology of laryngeal tuberculosis than is generally supposed. Gastrostomy, and thereby the elimination of the swallowing of food is an important adjuvant in the treatment of laryngeal tuberculosis. I shall combine the two methods in the future in suitable cases and hope to report my observations.

In order that this method should have a thoroughly fair trial, my patients have received no additional local treatment following artificial paralysis of the recurrent nerve; however, in conclusion, I would say that this method is not intended to be the only treatment for these cases, but should be used in combination with the usual therapy of tuberculosis of the larynx.

65 East 87th Street.

THE NEW YORK ACADEMY OF MEDICINE.

SECTION ON LARYNGOLOGY AND RHINOLOGY.

(*Continued from page 698.*)

Experiences With the Dowling Treatment: Two Cases. Dr. Saul Knopf.

(To appear in a subsequent issue of THE LARYNGOSCOPE.*)*

DISCUSSION.

DR. D. J. FASSETT: I have been doing some work of the kind that has been brought out tonight and also that of Dowling and others who utilized this line of thought, and can concur in all that Dr. Knopf said. I would like to supplement one thing, and would like to know of any men who have used in conjunction with this method not iodid of potash but small doses of iodid of soda. I would like to have some of the young men try that out; it produces less irritation, less lacrymation, and less staining.

Dr. Fassett expressed agreement with Dr. Knopf in regard to the non-packing after submucous or any intranasal operation as a rule. He said that anyone who has had this operation would agree that it is an abomination, and unless there is so much tearing of the membrane that co-operation of the parts is poor it should not be done.

He has used three methods: Simpson splints, vaseline gauze and finger-clot packing, and has found that his patients are better satisfied without packing. In the nose there is less secondary bleeding, less turgescence, less danger of Eustachian infection, and no greater danger of clot infection between the membranes. This applies to non-ambulatory cases only.

DR. KNOPF said that the aim in sinus infection treatment is to secure ventilation and drainage; he was sure that with the Dowling method of treatment rapid drainage could be secured, from the fact that the turgescence is decreased, you get more rapid ventilation, the ostia will open up more rapidly and the natural drainage will relieve the sinus infection.

Carcinoma of Larynx in a Female; Laryngectomy. Dr. Gouverneur Morris Phelps.

This patient is age 50 years and has always enjoyed good health until two years ago, when she complained of hoarseness. For this she was treated by sprays, etc. Last March she came to Dr. Harmon Smith's clinic at the Manhattan Hospital. There Dr. Edgar Farr removed a piece of tissue from an ulcerated tumor of the larynx. This proved to be epithelioma. A Wassermann test was negative.

On April 7, I performed a laryngectomy. This was done with 0.5 per cent novocain solution.

The operation consisted of a median incision from the hyoid bone, to 1 inch below the episternal notch. The larynx was now skeletonized, and the upper end of the trachea freed. The trachea was then divided at its junction with the cricoid. The larynx was packed from below with gauze and separated from the pharynx and esophagus. As fast as the upper border of the larynx was cut away from the pharynx the pharyngeal opening was sutured with interrupted silk sutures in such a way that as many as possible of the knots were left on the inside of the pharynx. This row of silk sutures was reinforced with a second row of fine chromic sutures. The upper end of the trachea was sutured to the skin with silkworn gut. Two deep mattress sutures, passing below the third ring and out through the sternomastoid muscle, acted as stays to relieve the tension.

The whole wound was then packed with a moist 1 per cent solution of formalin gauze. Finally four wicks of packing soaked in 1 per cent solution of formalin was inserted in the upper and lower angles of the wound, extending laterally beneath the sternomastoid muscle. A fifth was inserted in the midline down to the pharyngeal suture line. These were left in for two days, and except for the one in the midline were not renewed.

DISCUSSION.

DR. KNOPF: This case again brings out the important fact that a benign tumor can change to a malignant one. The man that took care of this case two years ago removed a mass which proved to be a papilloma. Shortly following that the patient had relief of the hoarseness and was well for a year. Then the recurrence came on, with the second removal, which again proved to be papilloma. This past year she again had hoarseness. It is clear that this mass was entirely different from the previous masses, for the biopsy report was carcinoma and at operation it was definitely proved to be such.

Another point is that on looking into the larynx the cord itself was apparently involved. When the larynx was removed, the mass was not only on the cord but extended quite a distance down into the larynx—so that one is easily deceived by examination merely.

Another interesting feature was the convalescence of the patient. At no time did she have difficulty of any kind. Immediately following the operation she had a slight rise of temperature of 101,° which came down rapidly and remained so afterward. and there was no stormy convalescence, such as is usual in these cases. There were no raw surfaces of any kind, and healing was by primary union, which is very unusual. One spot discharged for a few days but healed after local applications of mercurochrome. As could be seen, she is now apparently well, and has been so, within a week or ten days after the operation. Dr. Phelps certainly is to be congratulated upon the wonderful result of the operation.

DR. PHELPS said that benign tumors, or tumors of low malignancy, tended to become malignant, if cut into, or incompletely removed.

The reason that this case healed so nicely was probably due to the method of operating, thereby preventing contamination. The packing of the wound for a few minutes with gauze soaked in 1 per cent solution of formalin; tieing the suture knots on the inside of the pharynx has a tendency to keep the wound from becoming infected.

Dr. Phelps said that if incompletely removed when operated upon, a tumor has a tendency to recur in a more malignant condition. He has seen many instances.

A Case of Bilateral Abductor Paralysis. Dr. H. H. Forbes.

The patient had been examined by a number of men just before the meeting. He was age 26 years. The history was that when age 3½ years he had diphtheria and it was necessary at that time to use an intubation tube, which was retained in place—with three reinsertions—for twenty-six days. From that time on his voice had been husky and he had had more or less difficulty in breathing. About two years ago he developed a tuberculosis, which is now in the so-called quiescent stage—certainly a recession, if not a cured case. He has his living to make, and the amount of space he has to breathe through is perhaps about one-fifth of normal. He must do a certain amount of manual labor in his occupation, and when he starts to walk upstairs he has hyspnea. The cord is not only paralyzed, but there is an ankylosis of the arytenocricoid articulation, and also a partial involvement of the left cord. The left cord will perhaps open up one-third of normal.

The question was whether a cordectomy would help him or spoil his voice. The use of his voice was not so necessary in his occuupation as to have a sufficient amount of air in the lungs, and the case was presented with the hope of suggestions as to whether it was justifiable to do a simple dilatation or a cordectomy. The latter was not necessarily harmful in this instance, as it was not the question of a singer's voice.

DISCUSSION.

DR. KNOPF said that of course there were two methods open, as Dr. Forbes had suggested, either cordectomy or a bougie massage. In view of the fact that the man had a latent tuberculosis and that a cordectomy often produced quite a hemorrhage—especially from the anterior portion of the cord—and also notwithstanding the fact that if the cords are removed in toto an adventitious cord occurs, and, furthermore, in view of the fact that there was practically an ankylosis of the arytenocricoid articulation, he would advise a bougie

massage. He had had a number of cases of that kind, and had seen cases which had not only abductor paralysis, but others with adductor paralysis from intubation—and while it might sound strange to say that massage with the bougie had helped even the adductor paralysis, it was nevertheless true. He had seen that occur notwithstanding the fact that the cords had been widely separated. He hoped that Dr. Forbes would try the bougie massage in this case, and would some time report good results.

Plastic Nasal Operations: Presentation of Cases and Lantern Slides. Dr. Gustave Aufricht (by invitation).

Plastic surgery is the art and science which deals with disfigurements of the human body, particularly of the face. Contagious diseases destroying parts of the face, mutilating penalties adopted by certain races, such as cutting off the nose, and thousands of defects caused by wars, require a high development of plastic surgery. The World War presented a vast amount of this material, showing every imaginable defect of the face and body. This enormous demand was met by the preparedness of the surgery of the twentieth century. Great numbers of the war mutilated were concentrated in special hospitals and, with this unparalleled opportunity, many surgeons interested in this special field developed into sculptors of human flesh and constructed acceptable faces in cases of the worst disfigurements—creating new noses, new lips, new cheeks, orbital parts, etc. This experience of reconstructive surgery demonstrated clearly that the surgeon in this field must be equipped with something more than mere surgical skill or the usual requirements of the rhinologist or other specialist. The fact should be emphasized that the plastic surgeon is really a sculptor using surgical technique on human tissue: but while the sculptor works on lifeless clay with relatively simple instruments, the surgeon-sculptor uses the entire complicated armamentarium of the surgery, and his material is living, sensitive, human tissue. Instead of passive clay, he is modeling vital skin, bone, cartilage, and fat, with all their biological characteristics. Aside from his aim in producing an artistic form, he has to consider a large number of factors, such as anatomy, asepsis, healing, blood and nerve supply, shrinking, scar-formation, color, consistence, function.

In peace times, the practice of plastic surgery includes numerous cases of a purely cosmetic character, such as correcting lines of the face—particularly of the nose, the contours of which have such an important influence on the appearance and consequently on the psychology of the individual. In correcting a nasal deformity the nose must be considered not as a unit in itself but as a part of the whole face; it is not enough to change the deformity, the change must be an improvement. I will now show some cases of rhinoplastic correction with a brief lantern slide demonstration of the methods employed, which are those of my teacher, Professor Joseph, of Berlin.

This gentleman whom you see is age 50 years. Three years ago he had a melanosarcoma on the right side of the nose which was treated with radium and entirely disappeared but in its place left a radium ulcer, which remained for two years despite various non-surgical treatments, including diathermy. The first picture shows how it looked when the patient was referred to me. It involved the entire thickness of the skin and the corresponding bony wall of the nose. The problem in this case was caused by the thinness of the nasal wall. The usual method of extensive excision of the ulcer would remove the nasal wall altogether and leave the nasal cavity exposed. It was evident at once that free transplantation could not be employed in this case, so the difficulty was overcome by a pedunculated flap with a rather special technique, which will be illustrated on the screen. The wound healed in per primam intentionem, leaving the condition as you see it.

The second case is a woman, age 46 years, with loss of the tip of the nose corrected, by a pedunculated flap from the bridge of the nose.

(Two corrective rhinoplastic cases and a number of slides showing various rhinoplastic correction and the endonasal operative methods were then shown.)

PHILADELPHIA LARYNGOLOGICAL SOCIETY.

Meeting of January 5, 1926.

Paper: Tonsillar Infection as a Cause of Meniere's Disease. Dr. Judson Daland.

DISCUSSION.

DR. WILLIAM A. HITSCHLER: Recently I reported two cases of vertigo in which relief followed treatment of the faucial tonsils. In one case, that of a young man, age about 35 years, a tonsillectomy was performed in 1916. Since the operation he has had no recurrence of the vertigo.

The second case was that of a man, age 60 years. He had asthma in addition to the vertigo. Partial excision of the faucial tonsils two years ago, was followed by very marked relief to both symptoms. But on the day following my report of the case he had a severe attack of vertigo. This was attributed, by his family physician, to a gastrointestinal disturbance, upon the subsidence of which the vertigo phenomena disappeared. Two months have elapsed since and there has been no recurrence. All of the faucial tonsil tissue had not been removed, owing to a severe hemorrhage.

Paper: Acute Mastoiditis Without Apparent Middle Ear Symptoms. Dr. Morris A. Weinstein.

DISCUSSION.

DR. DINTENFASS: There are many types of atypical mastoiditis and the most dangerous one may present the least symptoms. The case reported had no discharge from the middle ear at any time and the only symptom referring to the ear was the temperature and the postauricular edema, which came on suddenly. A mastoidectomy was performed and to our surprise a great deal of destruction was found. This patient, however, made an uneventful recovery.

DR. MATTHEW S. ERSNER: Dr. Weinstein is to be congratulated upon the splendid results that he obtained in this case, his method of diagnosis and the manner in which he presented this case. His resume of the bibliography in this case is most interesting and will serve as good reference to writers reporting this type of case.

Atypical mastoids vary for many reasons. There are anatomical problems, the method of treatment and the type of organism. The most treacherous of all organisms is the streptococcus mucosa. The symptoms in this type of infection are practically nil, both objectively and subjectively. One of the most important symptoms is that the patient feels that he has an ear, but that it is "not just right."

In conclusion I wish to emphasize that all vague symptoms around the ear should be considered as potential mastoids with possible intracranial complications and should be studied from all angles, including the laboratory and X-ray examinations.

The Gradinego Syndrome in Mastoid Disease with a Report of a Case. Dr. Henry Dintenfass.

The gradinego syndrome occurs in the course of an acute otitis media and presents certain definite clinical symptoms, the most predominating of which is paralysis of the abduscens nerve. It is an extremely rare condition. Seldom will an otologist see more than three or four cases in a busy lifetime. The exact pathology of the syndrome is somewhat in dispute. The lesion is probably a localized circumscribed meningitis. A knowledge of the exact position and relation of the sixth nerve, the abduscens, is of great assistance in making a diagnosis. After the abduscens nerve pierces the dura it enters the triangularly-shaped space at the apex of the petrous pyramid called Dorello's canal. In this canal it runs near the inferior petrosal sinus. After leaving the canal it lies in

close proximity to the depression holding the gasserian ganglion. Forward from here it finds its way along the outer wall of the cavernous sinus, emerging through the sphenoidal fissure to enter the orbit. The paralysis of this nerve may be due to a secondary inflammation arising from the involvement of the adjacently lying bony area or from an inflammation of the dural structures surrounding the nerve and causing pressure upon it. The symptomatology and operative findings of the following case will help to formulate more definite ideas as to the etiology and pathogenesis of this condition.

On Sept. 26, 1925, a poorly nourished, white, female child, age 6 years, developed an acute otitis media of both ears, following an attack of influenza. A double paracentesis disclosed the presence of a considerable amount of sanguineous discharge on both sides. This discharge later became purulent. As the temperature continued for two weeks the child was sent to the Polyclinic Hospital for study. X-ray of the mastoids showed an extreme pneumatic type of development, but no positive evidence of disease of the bone. Symptoms pointing to a possible pericarditis and a pyelitis were found and were carefully considered as a probable source of the temperature. However, as the ears were still discharging and as the gland at the tip of the right mastoid was distinctly palpable, it was decided to drain both mastoids.

On Oct. 13, 1925, under nitrous oxid gas and oxygen anesthesia, the operation was performed. The uncapping of both mastoid processes disclosed two important facts. First, the absence of any great pathology; and second, the extensive pneumatic character of the bone found. Bacteriological examination of the pus obtained showed staphylococci and streptococci. Following the operation the child showed marked improvement, the temperature coming down to normal and remaining so. On the morning of the fourth post-operative day the patient complained of a severe pain in the tempoparietal region on the right side. Toward evening the pain, which she described as a "sticking pain," had extended over the entire face, particularly in the region of the upper teeth. The child became restless and irritable. The T. P. R. remained normal. The next day, the twenty-fifth day since the onset of the acute otitis media, a paralysis of the right abduscens nerve manifested itself. This was associated with diplopia and vertigo.

Following a thorough eye examination, Dr. Cowan reported that there was a restriction of the movement of the sphere of action of the external rectus on the right side. The media was clear. The disc margins were slightly blurred, especially above. The color was good. Scattered throughout the fundus were groups of round, well defined, various-sized, choroidal pigment spots.

The question of treatment was the all important problem. Would it be better to operate and explore the structures involved near the tip of the petrous pyramid, a rather deep and inaccessible portion of the anatomy, or should we temporize and try watchful waiting? It was decided that the patient be left alone and nothing radical attempted for at least forty-eight hours. At the end of this time an improvement was noted. Diplopia disappearing on the twelfth day following operation. Six weeks later no trace of paralysis remained.

In summarizing this case a number of outstanding features must be mentioned.

1. In the previous medical history of this child we find instances of lowered vitality and resistance, which is a factor in the formation of the condition.

2. The pneumatic character of the bone found, which offered very little resistance to the spread of infection to the petrous tip, the site of the trouble.

3. The lack of pathology present when the mastoids were uncovered, proving that this syndrome can and does occur even in ordinary cases of acute otitis media without the mastoids necessarily going on to suppuration.

4. The severe tempoparietal pain and the pain over the teeth explained by the nearness of the gasserian ganglion to the abducens nerve.

5. The advisability of the treatment being along conservative lines, since the prognosis of the true gadinego syndrome is very good.

6. An exact diagnosis, since there must be considered the possibility of the sixth nerve paralysis being due to brain abscess, sinus thrombosis and suppurative meningitis.

The neurological examination made by Dr. Yaskin revealed a right abduscens paralysis as noted above, a partial paralysis of the left facial nerve as shown by a drooping of the lip and a Babinsky on the left side.

DISCUSSION.

DR. GEORGE M. COATES: **Dr. Dintenfass is to be congratulated upon the splendid manner in which he presented his paper. Judging from his description, it is a definite gradinego case. The three fundamental symptoms were presented, such as pain in the face, paralysis of the sixth nerve and otitis media. There are many theories that attempt to explain the cause for the gradinego syndrome. It is interesting and probably plausible that the large and extensive cellular type cells are responsible for the gradinego.**

Should the Use of the Terms First, Second and Third Degree Nystagmus be Continued? Dr. George W. Mackenzie.

Meetings of April 6 and May 4, 1926.

Ossiculectomy in the Treatment of Chronic Purulent Otitis Media. Dr. Monroe D. Reese.

(To appear in a subsequent issue of THE LARYNGOSCOPE.*)*

DISCUSSION.

DR. GEORGE M. COATES: Ossiculectomy is a lost art and should be practiced oftener. The radical mastoid operation has replaced the ossiculectomy. The ossiculectomy has its place and in selected cases the results are gratifying.

DR. GEORGE W. MCKENZIE: Since we cannot obtain 100 per cent in our results when radical mastoids are performed, it is worth while trying ossiculectomy, especially in selected cases.

Heath claims 85 per cent in the modified radical mastoid, and Yankauer claims 60 per cent.

DR. MATTHEW S. ERSNER: I watched Dr. Reese's work with keen interest and on several occasions I referred some of my patients to him. I agree with him, that it is a safe, sound and conservative method. In the absence of marked bony necrosis, cholesteatoma, etc., ossiculectomy should be tried and in the event of failure, a radical mastoid can always be performed.

DR. PHILIP S. STOUT: Just a week ago a patient, Mrs. A. R., came to me. She is a German lady, age 52 years, who was operated upon in Europe at the age of 20 years. The operation was a bilateral ossiculectomy, with the removal of considerable of the bone covering of the posterior canal. The operation was done primarily to cure a marked "shwindle." The giddiness was so bad that she could hardly walk at times. Of course, she also had a bilateral purulent otitis media before the operation. Following the operation the giddiness improved and her ears remained dry, the discharge ceased, but she began to grow deaf until at the present time she has practically no hearing except that she hears a scream. Later the right ear developed tinnitus and this almost set her insane. Finally it got better and she thought her troubles were over, but some time ago the left ear developed tinnitus so badly that she now insists that unless something is done to relieve the condition she will do something desperate.

This one case does not prove anything particularly for or against the operation, only I thought it would be interesting to call attention to this case as the outcome of an operation done thirty-two years ago when ossiculectomy was more common than it is at present.

Primary Jugular Bulb Thrombosis with Numerous Metastatic Infections; Operations; Recovery. Drs. Henry S. Wieder and William Bates.

(To appear in a subsequent issue of THE LARYNGOSCOPE.*)*

DISCUSSION.

DR. M. S. ERSNER: I wish to congratulate Dr. Wieder on the manner in which he presented his paper.

I might suggest the study of the red blood picture in conjunction with the white blood cells. We must not forget that 50 per cent of all mastoids are caused by the streptococcus hemolyticus. The hemoglobin and red blood cells are therefore affected early in the disease. It is interesting to note the good results one can obtain by using Pregl's iodin intravenously. I should like to know whether there were any changes in the red blood picture after each administration and also what effects it had upon the blood picture.

Defects of Speech. Dr. Wm. J. Pepard.

(To appear in a subsequent issue of THE LARYNGOSCOPE.*)*

Differential Diagnosis and Treatment in Diphtheria. Dr. H. Hunter Lott.

(To appear in a subsequent issue of THE LARYNGOSCOPE.*)*

DISCUSSION.

DR. THOMAS MELNICK stressed the importance of early diagnosis and immediate immunization. He said that every hour lost with a case of diphtheria increases the mortality. Dr. Melnick claims that in his experience he found that it was best to administer large doses of antitoxin rather than too small a dose.

DR. S. S. WOODY: 1. Prophylaxis in diphtheria is not observed sufficiently and should be compulsory.

2. Early diagnosis is most important and immediate immunization is very essential. It therefore should be practiced. The toxin has a destructive chemical affinity for certain cells and the longer the treatment is delayed, the more damage is done.

3. Diphtheria should be differentiated from a follicular tonsillitis, Vincent's angina, quinsy, retropharyngeal abscess, streptococcus angina, pneumococcus angina, T. B. laryngitis and syphilis. There may also be a combination of any of these diseases and to be on the safe side one should administer antitoxin first of all, and then study the case.

Dr. Woody has not observed any ill effects from the result of antitoxin nor any discomfort caused by the antitoxin. The results accomplished are most gratifying.

Laryngeal diphtheria may be confused with streptococcus infection. In streptococcus the edema predominates, but not so in diphtheria. In a streptococcus infection we do not have the loss of voice, while in diphtheria there is a loss of voice.

The surest way of examining the larynx is by using the laryngoscope.

Treatment: Antitoxin should be administered. The intramuscular method is the best. Rest is most essential.

Dr. Woody has stopped the intravenous method of antitoxin as he finds that the reaction is too violent. The dose is guided by the local lesion, duration of the disease, glandular involvement, susceptibility and general toximia.

A good rule to be carried out is to administer a large dose of antitoxin, put the patent to bed and treat the complications as they appear. Antitoxin should be administered irrespective of a negative culture. The best and only treatment for the prevention of diphtheria is to remove diseased tonsils and adenoids.

Intubation and Tracheotomy in Diphtheria. Dr. Arthur J. Wagers.

(To appear in a subsequent issue of THE LARYNGOSCOPE.*)*

Laryngeal and Esophageal Sequelae of Diphtheria. Dr. Louis H. Clerf.

(To appear in a subsequent issue of THE LARYNGOSCOPE.*)*

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY.

Annual Meeting of April 26-28, 1926.

Fourteenth annual meeting of the Pacific Coast Oto-Ophthalmological Society held at San Francisco, Calif., April 26-28, 1926. Officers elected for 1926: President, Dr. Carroll Smith, Spokane, Wash.; First Vice-President, Dr. William Mellinger, Santa Barbara, Calif.; Second Vice-President, Dr. Frank Burton, San Diego, Calif.; Secretary-Treasurer, Dr. Walter F. Hoffman, Seattle, Wash.

Intraocular Growth in Children; the Problems of Diagnosis. Dr. Frederick A. Kiehle.

Paracusis. Dr. Vern O. Knudsen and Dr. Isaac H. Jones.

(Published in full in September issue of THE LARYNGOSCOPE.*)*

Dental Osteitis and Maxillary Sinusitis. Dr. Frank A. Burton.

Dental osteitis and necrosis more common complication of maxillary sinusitis than ordinarily supposed. Quite a percentage of stubborn chronic maxillaries due to dental osteitis. In such cases, root disease primary condition. Often difficult to establish relationship between previously extracted diseased teeth and present complaint. Recommends thorough curettage of alveolus when diseased tooth is extracted. Complaints differ from almost nil to marked swelling, tenderness, pain. Where fistula, pus discharge, bad taste, thorough X-ray study often necessary. Careful clinical history important first step. Sometimes alveolus closes below and osteitis continues in direction of maxillary sinus. Diagnosis necessary to cure, failure in diagnosis likely to occur unless looking for complication.

The Relation Between Audition and the Circulation of the Blood in the Head. Dr. Hamilton Willson.

Certain peculiarities obtain in the circulation of the blood of the head. Within the cavum the walls of the vessels are extremely thin; the diameter of the vessels is large; in parts the circulation dispenses with capillaries; the volume of blood remains practically constant, increase or decrease of the functional activities within the cavum being taken care of by the increase or decrease of the rate of the flow of the blood through the vessels.

The circulation is unique, also, in being influenced by the amount of cerebrospinal fluid within the ventricles. And since the floor and lateral walls of the fourth ventricle can be regarded as the primary terminal station of the vestibular nerve, any increase or decrease in the pressure of the cerebrospinal fluid within the ventricle can disturb hearing. This fluid is also in relation to the fluid within the inner ear; and since the pressure of the cerebrospinal fluid can be made to vary with postural changes, compression of the neck vessels, etc., can be made to affect the hearing.

Hence the influences of hydrostatics, barometric changes, thermal and chemical changes, etc., have especial influence upon the hearing.

From the fact that a part of the ear mechanism depends upon air vibrations for its functioning disturbances of the areostatic equilibrium in that part of the ear affects the hearing peculiarly.

So, too, does disturbance of the various "complements" in the circulation. The complement between the vagotonus and the sympatheticotonus; the complement between the splanchnic and the cerebral circulation call for especial mention.

So that practically all the forces of nature come into play in the operations of the organ of audition. Arteriosclerosis, the various reflexes, emotional stress, toxic poisoning, dietetic errors, improper modes of living, of working, etc., all contribute.

Hence, anemia will give progressive and permanent deafness. As a rule increasing the amount of blood in the head will increase the acuity of audition within physiological limits and decreasing the amount will decrease the hearing; but prolonged increase or decrease will destroy the hearing.

DR. CUNNINGHAM reported having had twenty-six nonmalignant strictures of the esophagus. Sixteen were due to drinking lye. One to drinking nitric acid. Four at the level of the cricoid, and one at the hiatus were of unknown cicatricial origin. Three congenital strictures at the hiatus and one congenital atresia at level of the bronchus. He had twenty-eight cases of functional stenosis. Fourteen were spasms of psychic origin. Four at the hiatus due to ulcers simulating cardiospasm. Ten were cases of true functional stenosis at the hiatus (commonly called cardiospasm), the youngest being age 4½ years.

He also reported sixty-one cases of foreign bodies impacted below the level of the pharynx. Several cases were reported in detail; among them was the recovery of a child from mediastinitis, due to a false passage of an esophagoscope extending from pyriform sinus to the diapraghm, also an abscess of the mediastinum which caused stenosis of the trachea with unusual involvement of the laryngeal nerves. Both abductors and both internal tensors were paralyzed with the escape of both abductors.

The Cure of Chronic Suppurative Nasal Conditions by Drainage Through the Maxillary antrums. Dr. Fred Stauffer.

Paper deals with the importance of correct diagnosis, including X-ray. Causation of chronic nasal discharges is repeated clods in the head, first affecting the ethmoidal cells, then involves most frequently the antrums from their dependent position, and poor drainage. Attention is drawn to the causative effect of deflections of, and exostasis from the nasal septum, interfering with the drainage from the accessory sinuses. Recent experience has shown that infected antrums are more frequently the cause of chronic suppurations from the nose than formerly was believed. The paper stresses the importance of first establishing good ventilation and drainage by correcting abnormalities of the septum, and secondly, drainage of the antrums by a Caldwell-Luc operation, which not only drains the antrums, but often cures up mucus polypi and suppuration in the ethmoids because of drainage from below. Numerous lantern slides were shown to stress the advantages of the operation through the canine fossa in preference to any of the internal operations. This method was not put forth as a panacea for all chronic nasal discharges, but it is claimed that many cases subject to chronic suppurative ethmoiditis with polypus formation can be cured by this method which are not amenable to other forms of treatment.

The Role of the Ophthalmologist and Oto-Rhinologist in the Diagnosis of Ductless Gland Disease. Dr. H. Lisser.

It is important to develop the "prepared-open-mind" toward this subject, in other words, to be neither ignorantly credulous nor cynically intolerant. It is possible that such diseases as cataract, glaucoma, retinitis pigmentosa, keretaconus, retinal hemorrhages and detachment of the retina, blue sclera, vasomotor rhinitis, hay fever and otosclerosis, may be directly or indirectly related to derangements of endocrine function, but in none of these conditions has an incretory origin or participation been convincingly established. The action of a hormone such as adernalin in reducing intraocular tension in glaucoma or in cutting short an attack of asthma, is probably pharmacodynamic and is not to be construed as supplementing a temporary adrenal insufficiency. Therapeutic conclusions, whether positive or negative, will have more significance when extracts of adrenal cortex, ovary, testicle and anterior hypophysis, reach the same potency and reliability as insulin, adrenalin (from the adrenal medulla), pituitrin (from the posterior hypophysis), thyroid extracts, and Collip's parathyroid extract.

Most of the well recognized endocrine syndromes present important manifestations of glandular dysfunction in the realm of the eye, ear, nose and throat. This was demonstrated by showing pictures of acromegaly, gigantism, hypophyseal infantilism, post-adolescent hypopituitarism, Larence-Moon-Biedl syndrome, Christian's syndrome, tetany, diabetes mellitus, Addison's disease,

virilismus, eunchoidism, exophthalmic goiter, adematous goiter, with intrathoracic extension, childhood and adult myxodema, endemic cretinism and Mongolism. Some of the complaints in these endocronopathies are of such a character as to induce the patient to seek the specialist without realizing that the symptoms in his eyes, ears, nose and throat are due to profound disturbances originating elsewhere in the body, and it will then be the province of the specialist to recognize this fact and prescribe appropriate therapy or refer the patient to an internist qualified in endocrine diagnosis.

It is desirable that future contributions to this field strive to separate fact from fancy. They should state frankly which of their conclusions were derived from bedside observation or laboratory experiment and which of their conclusions emanated from a "projective imagination."

DR. WALTER HOFFMAN reported seven cases of paresis of convergence unaccompanied by a paresis of accommodation or any other ocular muscle, all secondary to epidemic encephalitis lethargica. The condition could probably be more properly termed a suppression of convergence, rather than a paresis, as there was no paresis of the internal recti or any other ocular muscle.

Changes in the Refraction in Diabetes Mellitus Hyperopia. Dr. A. B. Dykeman.

Four cases of the condition were reported.

Bronchoscopic Studies of Some Conditions of the Respiratory Tract. Dr. Simon Jesberg.

Modern bronchoscopy is being more concerned with conditions other than removal of foreign bodies. In a fiscal year at the Bronchoscopic Clinic of the Eye and Ear Hospital of Los Angeles, 341 endoscopic examinations and treatments of which only thirteen were foreign bodies.

X-ray signs of air trapping were described; partial air trapping in minor degrees of obstruction of a bronchus is better detected by fluoroscope than by Roentgenogram.

Report of two cases of foreign body in the bronchi with slight obstruction, diagnosis of partial air trapping was made with the fluoroscope.

Report of eleven cases of various conditions of bronchial obstruction: Case 1. Obstruction of left bronchus by a polyp., after pertussia. Case 2. Obstruction of bronchus by tuberculous mediastinal gland. Case 3. Bronchial obstruction, with air trapping left lung, in an infant with large thymus. Case 4. Obstruction of right bronchus by swollen mucosa and pressure, a foreign body being in the left bronchus. Case 5. Obstruction of left bronchus due to tuberculous granuloma (lupus) of trachea. Case 6. Obstruction of air passages by viscid secretions during chickenpox. Case 7. Obstruction of bronchus and collapse of right lung during bronchopneumonia. Case 8. Partial obstruction of left bronchus due to pericarditis. Case 9. Tracheobronchial obstruction due to diphtheria. Case 10. Atalectasis of new-born. Case 11. Spontaneous pneumothorax in 2-year-old child, simulating foreign body.

Adenoid in Adults. Dr. Wilson Johnston.

In reviewing the literature the author finds that from 25 to 30 per cent of the malignancies of the nasopharynx have been operated upon for the removal of tonsils and adenoids within from one year to three weeks previous to a diagnosis of malignancy being made

From these statistics he believes that in the early stage of malignancy in a percentage of cases, there is an enlargement of the tissues at the site of the pharyngeal tonsil which resembles adenoid tissue

He reports four types of cases:

1. Sarcoma of the nasopharynx, complicated by Vincent's angina in which a diagnosis was made by excision of gland from the neck.
2. Recurrent adenoid in a patient, age 25 years.
3. Carcinoma of the nasopharynx with a smooth enlargement in the midline.
4. Young adult with persistent adenoid growth.

It is to the latter type of cases that the author wishes to call attention, in that they may receive more careful consideration. If treated surgically, the removed tissue should be submitted to microscopic examination. He believes in and advises the treatment of these patients with radium, and exhibited a method of application and screening.

DISTRICT OF COLUMBIA MEDICAL SOCIETY.

OTOLARYGOLOGICAL SECTION.

Meeting of April 23, 1926.

The Otolaryngological Section of the District of Columbia Medical Society met on Friday evening, April 23, 1926. Cases were presented by Dr. F. C. Schreiber and a paper read by Major Robert E. Parrish.

Dr. Schreiber presented the following cases:

Case 1. This case was a residual chronic ear; age of patient, 52 years; duration of suppuration approximately ten years, starting after an attack of measles when age 10 years. In the period after the ten years of intermittent discharge the ear has been entirely free of discharge. Previous to Christmas of this year this patient merely presented this condition without any great depletion of hearing. Since that time after contracting an acute cold her hearing has been markedly reduced. She can hear ordinary conversation ad concham. The remarkable point in this ear was the demonstration of the stapes in the oval window and the promontory and round windows beneath. There was full epidermization of the entire cavity. The head, crura and footplate of the stapes were clearly seen.

Case 2. This case was that of a neglected mastoidectomy, simple, left ear, done sixteen years previously. Followed an attack of measles. Clamps were allowed to remain in position a period of six weeks, with resulting erosion of the posterior incision. Suppuration continued a period of three months following this simple operation. A radical was performed at the Episcopal Hospital after that duration of time by the late Dr. Monte Griffith. The cavity was well proportioned, but there remained but small flaps for the postauricular wound. These subsequently broke down, converting the cavity into an open wound. Some months later this patient was taken to Baltimore and was operated upon by Dr. Friedenwald, who made a plastic and placed skin grafts within the radical cavity. The skin grafts failed to hold, and the posterior mastoid incision again opened. The posterior canal wall is collapsed and it is in intimate contact with the anterior cartilaginous wall. The Eustachian tube is patent and continues to suppurate. There is an area of erosion on the anterior tympanic wall high up, as well as a small area over the tegmen tympani. The remaining part of the cavity is completely epidermized.

DISCUSSION.

Dr. Walter A. Wells stated that he wished to thank the author for presenting such interesting cases affording a study of anatomical parts on the living. He suggested experimentation on the first case to determine stapedial fixation, suggesting the Gelle test as well as direct passive motion to the stapes. He had never seen a case comparable to this one. He suggested watchful waiting in the second radical case, suggesting the use of mercurochrome and other medication designed to reduce the infection. He cautioned against a plastic. Should these measures fail, he stated he would attempt to curette the Eustachian tube gently and other places suggesting areas of necrosis.

Dr. J. H. Bryant suggested the use of burrs carefully selected and an attempt to close the Eustachian tube in this way. He felt a plastic should be attempted, but did not enter into details regarding the manner in which it should be attempted.

Dr. Schreiber replied to Dr. Bryant, saying that he would hesitate to do any plastic operation at the present time, as he feared there was too much infection of the bone present and in view of the fact that previous plastics had not been done successfully.

Chronic Progressive Deafness, with Particular Reference to the Clinical Aspect. Maj. Robert E. Parrish.

(To appear in a subsequent issue of THE LARYNGOSCOPE.*)*

DISCUSSION.

DR. WILLIAM H. JENKINS discussed Dr. Parrish's paper. He said it was pathetic to turn these deaf patients away and not keep in touch with them. He suggested that these younger subjects be encouraged to take up lip-reading as early as possible. Dr. Jenkins was of the opinion that the early care of these patients in the way of removing tonsils and adenoids and treatment of the sinuses would prevent many cases of deafness.

DR. G. B. TRIBLE stressed the fact that in examining a great many of these cases in the navy a history of early infection was usually developed.

DR. OSCAR WILKINSON was of the opinion that practically all of the so-called catarrhal deaf cases had some nerve involvement. This certainly obtains sooner or later, and should be looked for. Dr. Wilkinson also agreed with the essayist that the general practitioner was particularly slow in referring ear cases to the specialist, and should be encouraged to refer cases earlier, as he felt they did not realize that early lesions which produce deafness are as amenable to treatment as any other conditions of the system. He also stressed the fact that the ear men now realize that the varioust foci of infection cause nerve deafness in practically as high a percentage of cases as in ophthalmology. Notwithstanding the fact that the ear men have been much more tardy in recognizing this fact than the eye men have.

DR. WALTER WELLS reviewed the difficulty in determining the difference in mixed deaf cases: just how much is due to conductive lesion and how much to nerve lesion. He also suggested that we do as much as we could for these patients in the way of treatments, in order that they not wander off into the hands of charlatans. Dr. Wells also stressed the importance of looking for the foci of infection.

DR. OSCAR WILKINSON, *Reporter.*

OTOLARYNGOLOGICAL SECTION.

Meeting of May 21, 1926.

DR. H. T. DAVIS, *Chairman.*

Dr. A. M. Zinkham read a paper on Vincent's angina and reported cures of, obstinate cases of same by the use of sodium perborate.

He stated that failures after the use of salvarsan, chromic acid, the ultra-violet ray, etc., are frequent, particularly in the gingival infections. Tonsillectomy is recommended in obstinate cases of tonsillar infection.

Treatment consists of a mouth wash of peroxid of hydrogen, followed by a saturated solution of sodium perborate. Relief follows within a few hours, and cure within a week.

Dr. H. T. Miller suggested that each patient with Vincinet's angina be examined for syphilis.

Dr. Oscar Wilkinson stated that he would hesitate to do a tonsillectomy in the presence of any acute infection.

Dr. G. B. Trible said he had seen one fatal case of Vincent's angina which had lung involvement.

In closing his paper, Dr. Zinkham stated that he operated on these cases only as a last resort. He said he had found the records of six cases of Vincent's angina which occurred while the patients were receiving intravenously 606.

DR. OSCAR WILKINSON, *Reporter.*

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

Meeting of Jan. 18, 1926.

Foreign Bodies in the Air and Food Tracts. Dr. Hilliard Wood.

Summary of cases by Dr. Wood during the year 1925, for the Nashville Academy of Ophthalmology and Otolaryngology.

1. The youthfulness of patients in this series; one was 6½ months, one 13 months, one 16 months, one 17 months, one 21 months, one 2 years, so that six of them, or more than one-half of them, were under 2 years, and two of them were under 1 year of age. This made bronchoscopy difficult on account of the small size of the larynx in young infants, and the inability to introduce through the larynx a tube large enough to operate through.

I believe in such cases that a tracheotomy followed by low bronchoscopy would, in the main, be more successful, both in removing the foreign body and in avoiding the danger of subglottic edema.

2. Bronchoscopy on children without ananesthetic has in it much of the ideal, but we got along much better when we used ether.

3. Pneumonia as an after-complication, when a general anesthetic is used, cannot justly always be charged against the anesthetic, as the tenth case in this series was not bronchoscoped, but coughed the fragments of peanuts up, and a day or two later developed pneumonia.

4. Perforation of the esophagus by an open safety pin occurred in the fifth case. This perforation was proven by post-mortem.

5. The fourth case is the record of a silver quarter which is supposed to have been retained for four months in the trachea of a child age 17½ months, at the time of its removal from the trachea post-mortem.

According to the evidence this silver quarter entered the trachea of a child, four months previous, that is, when the child was age 13½ months. The coin must have entered through the larynx in an anterioposterior position, but was found by the X-ray and post-mortem in a transverse position, which is the position a coin usually occupies in the upper end of the esophagus.

This is, to my mind, the most puzzling and incomprehensible fact brought out in this report.

Foreign bodies in the air and food tracts, Dec. 31, 1925:

Name: J. P. A. Age: 17 months. Sex: M. History: F. B. swallowed, followed by suffocation, coughing, cyanosis, crying, etc. Symptoms: Respirator distress. Defective breathing in R. lung. X-ray Findings: Marked contraction of R. lung. Diagnosis: F. B. in R. lung. Time Retained: 7 days. Treatment: Peroral bronchoscopy. Three days later low bronchoscopy. Anesthesia: None. Novocain. Result of Operation: One-half of bean removed. Other half removed. Nature of Foreign Body: Bean. Complications: Subglottic edema. End Result: Recovery.

Name: M. L. F. Age: 13 months. Six: F. History: Patient fell, followed by violent strangulation, coughing, suffocation, etc. Symptoms: Coughing and fretful. X-ray Findings: Slight cloud in region of R. bronchus. Diagnosis: F. B. in R. bronchus. Time Retained: 5 days. Treatment: Peroral bronchoscopy. Anesthesia: None. Result of Operation: Failed to find F. B. Nature of Foreign Body: ??. Complications: Mild subglottic edema. End Result: Three weeks later coughed up one-half corn.

Name: V. E. B. Age: 8 years. Sex: F. History: Patient aspirated a metal cap off of a whistle. Cough folowed. Symptoms: Cough. X-ray Findings: F. B. in R. bronchus, low down. Diagnosis: F. B. in R. bronchus. Time Retained: 4 months. Treatment: Peroral bronchoscopy. Anesthesia:

Ether. Result of Operation: Metal cap removed. Nature of Foreign Body: Metal cap. Complications: None. End Result: Recovery.

Name: B. P. V. Age: 17½ months. Sex: M. History: Labored breathing, cough, difficult swallowing, general poor health. Symptoms: Same as history. X-ray Findings: Coin in upper end of esophagus. Diagnosis: Coin in upper end of esophagus. Time Retained: 4 months. Treatment: Esophagoscopy. Anesthesia: None. Result of Operation: Failed to find F. B. Nature of Foreign Body: Silver quarter. Complications: Pulmonary edema and death. End Result: Quarter removed post-mortem from trachea.

Name: R. W. R. Age: 6½ months. Sex: M. History: Patient swallowed an open safety pin. Symptoms: ??. X-ray Findings: Open safety pin in middle of esophagus. Diagnosis: Sharp end of pin up and to the right. Time Retained: 1 day. Treatment: Esophagoscopy. Anesthesia: Ether. Result of Operation: Failed to find pin. Nature of Foreign Body: Safety pin. Complications: Pin perforated esophagus. Pneumonia. Death. End Result: Perforation of esophagus post-mortem.

Name: J. H. Age: 21 months. Sex: F. History: Swallowed one-half of safety pin. Symptoms: Choking, suffocation, wheezing, vomiting. X-ray Findings: One-half safety pin in trachea R. bronchus. Diagnosis: One-half safety pin in trachea and bronchus. Time Retained: 4 hours. Treatment: Peroral bronchoscopy. Pin removed through esophageal speculum. Anesthesia: Ether. Result of Operation: Pin removed. Nature of Foreign Body: One-half safety pin. Complications: Subglottic edema. End Result: Recovery.

Name: W. C. Age: 40 years. Sex: M. History: Patient aspirated chewing tobacco. Symptoms: Cough. X-ray Findings: No X-ray made. Diagnosis: Tobacco in trachea. Time Retained: 5 days. Treatment: Bronchoscopy. Anesthesia: Ether. Result of Operation: Removal of fragments of tobacco. Nature of Foreign Body: Chewing tobacco. Complications: None. End Result: Recovery.

Name: M. P. Age: 17 years. Sex: F. History: Swallowed a straight pin one hour ago. Symptoms: Pain in throat. X-ray Findings: No X-ray made. Diagnosis: Pin in lower pharynx. Time Retained: 1 hour. Treatment: Pin removed with fauceps. Anesthesia: Cocain. Result of Operation: Pin removed. Nature of Foreign Body: Straight stickpin, 1¼-inch long. Complications: None. End Result: Recovery.

Name: F. A. F. Age: 2 years. Sex: M. History: Two months ago swallowed concentrated lye. Yesterday swallowed marble. Symptoms: Inability to swallow anything, even fluids, since. X-ray Findings: F. B. probably marble in esophagus. Diagnosis: Marble in lower third of esophagus. Time Retained: 2 days. Treatment: Murphy drip for water hunger. Anesthesia: None. Result of Operation: Marble passed into stomach. Nature of Foreign Body: Marble. Complications: Stricture of esophagus. End Result: Recovery.

Name: L. T. A. Age: 16 months. Sex: M. History: Swallowed mashed peanuts. Symptoms: Cough. X-ray Findings: None made. Diagnosis: Probably mashed peanuts in the L. bronchus. Time Retained: 1 day. Treatment: Expectant. Anesthesia: None. End Result: Patient returned home F. B.

Name: K. C. Age: 3 years. Sex: M. History: Swallowed penny. Symptoms: None. X-ray Findings: Coin in middle esophagus. Diagnosis: Coin in esophagus. Time Retained: 3 hours. Treatment: Esophagoscopy. Anesthesia: None. Result of Operation: Failed to find F. B. Nature of Foreign Body: Penny. Complications: None. End Result: Found in stomach by fluoroscope.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

Meeting of Dec. 11, 1925.

DR. D. L. TILDERQUIST, *Chairman.*

DR. JOHN F. FULTON presented a case of imperfect development of the right ear: The child was age 7 years. The mother had a severe attack of influenza shortly before the child was born. She believes this to be the cause of the defective ear. You will notice the auricle is imperfectly developed, part of the helix being absent and there is no opening into the external auditory canal. The hearing is certainly very defective on this side. Embryologists tell us that this condition is due to disturbance of the closure of the first branchial cleft and is often associated with failure of development of other parts of the facial bone and even cleft palate. The hearing of the other ear is normal. The child seems normal in every way with the exception of the defect already described. Inasmuch as she has one perfect ear, are we justified in resorting to any operative procedure for the relief of this congenital defect? Report of the Roentgen examination follows:

"Lateral comparative plates were made of the mastoid processes. These show that the bony development and the cellular structure of the mastoid processes have been developed symmetrically on both sides. The mastoids are of moderate size and cellular distribution. The internal and external auditory meati are symmetrical on both sides and present a normal appearance. The mastoid processes are normal in their pneumatic appearance. There is no evidence of pathological change.

"Conclusions: Normal symmetrical development of mastoid and surrounding bony structure. No evidence of developmental anomaly or pathological change."—Dr. R. G. Allison.

DISCUSSION.

DR. CAMP thought this case was very interesting. He stated that they had had in the past ten years at least three such cases. They were all children and all of them were operated. He stated that the X-ray led them to suspect there was a bony canal, but they found at operation that the canal was absent. He said in the case shown tonight the canal could not be palpated, but when one looked at the X-ray it looked as though there was a canal present. Dr. Camp stated that their patients were younger than this one. He thought it would be worth while, in view of the X-ray pictures, to explore this case and give her the benefit of the exploration. If bone conduction and labyrinth reactions are present he thought it would be worth while to operate.

DR. SCHWARTZ stated that he had had one case similar to this, the child being somewhat younger than this one and differing in that there was a vestige of an external auditory canal. On the strength of that, an exploration was done and it was found that there was a bony external canal present. A two- or three-stage plastic operation was done and the child eventually had a good auditory canal. Dr. Schwartz stated that there was not quite so much microtia in his case as in this one and the external ear was almost normal, but the canal was almost completely blocked. His patient was only age 3 years and they could not determine the hearing except by the cochleopalpebral reflex and she responded to that.

DR. TILDERQUIST stated that he personally had not come in contact with a case like this one. He had had one case of obstruction of both canals in an adult, due to cicatricial contraction, and had got very good results by inserting glass tubes, gradually putting in larger ones each time. The patient had recently come back with one canal closed and he intended to use the dilators again.

DR. K. C. WOLD reported a case of meningitis following radical mastoidectomy; recovery.

C. T., age 12 years, referred by Dr. Anderson, of Plum City, Wis. The family history was negative. The patient had measles at age 7 years, and has had intermittent discharge from both ears for eleven years, and almost constant discharge from the left ear for four years.

Examination showed slight mucus discharge from the right ear, and profuse, thick, offensive discharge from the left ear. Hearing: whispered voice, right, 6/15; left, 1/15. A diagnosis was made of chronic suppurative mastoiditis.

An operation was performed on August 14, as follows: Complete exenteration of the left mastoid, antrum and attic cells. There was much granulation present. Plastic flap of the canal was made into the mastoid cavity.

The patient made an uneventful recovery and on August 20, six days after the operation, was sent home with directions to the local doctor for post-operative care.

On the third day after arriving at home, August 24, she complained of feeling tired and having pain in the left ear . She became listless and seemed feverish. Two days later, August 26, at 7 a. m., had six or seven convulsions lasting over a period of two hours. She became unconscious, and in the afternoon had two more convulsions. This was followed by an apparent paralysis of the right arm and leg, with stupor. The next day the mental condition was markedly improved, and on August 28, day following, she was brought to St. Paul. The history of the case and symptoms led to the temporary diagnosis of brain abscess, and preparations were made for operation.

On arrival at the hospital, the patient was fairly clear mentally and unable to use the right arm and leg. Temperature was 104° F., pulse 114, respiration 28. Drs. Ball and Engberg, neurologists, were called in consultation and reported as follows: Marked Kernig and neck rigidity, without pupillary disturbance, weakness of both lower extremities and right arm; deep reflexes gone in right leg, reduced in left; no sensory disturbances present, and patient conscious. Spinal puncture was performed and revealed a cloudy fluid under increased pressure.

A temporary diagnosis of septic meningitis was made and 30 c.c. of antimeningicoccic serum was given intraspinously. This was repeated on two successive days. After the third day the patient's temperature became normal, she seemed bright, and Kernig and neck rigidity was almost absent.

On the fourth day in the hospital, Sept. 2, the patient's condition became worse again ,and 30 c.c. of slightly milky fluid under moderate pressure was removed and 30 c.c. of antimeningococcic serum was injected. Two days later, Sept. 5, this was repeated, following which the patient gradually became free from all signs of meningeal irritation and went on to an uneventful recovery. She left the hospital in nineteen days after admittance.

Laboratory findings were as follows:

1. Leucocyte count beginning with 15,000 and gradually reduced to 9,900.

2. Spinal fluid: Cell count decreased from 4700 to 30 with P. M. N. decreasing and lymphocytes increasing. Nonne negative except for a faint trace in the first specimen. No organisms were found.

This case is most interesting from the standpoint of an unusual course of events following a radical mastoid operation. The complications which first come to mind following mastoid operations are brain abscess, meningitis and septic sinus thrombosis.

The history obtained over long distance telephone, of convulsions, paralysis on opposite side of the body from the operation, remissions in consciousness, led to the diagnosis of a probable brain abscess, with immediate operation indicated. On arrival at the hospital, the subsequent examination showed the absolute contraindication to surgical interference.

The following questions come to mind with regard to this case:

1. Was this a direct extension from the mastoid region with diffuse meningitis?

2. Was it a localized meningeal infection, which drained back into the mastoid cavity after causing temporary irritation?

3. Was it a coincident epidemic meningitis which had nothing to do with the operation?

DR. WALTER CAMP, *Recorder.*

Meeting of January 15, 1926.

DR. D. L. TILDERQUIST, *Chairman.*

The regular monthly meeting of the Minnesota Academy of Ophthalmology and Otolaryngology was held in the Hennepin County Medical Society rooms, Donaldson building, Minneapolis, on Jan. 15, 1925, at 8 p. m.

DR. HORACE NEWHART gave a talk, entitled "Some Observations on Audiometry" and demonstrated several audiometers.

The following is an abstract of his paper:

Audiometry as developed during the past two years represents a very important advance in the field of otology. For the progress which has been made the otologist is chiefly indebted to the physicist, notably the telephone engineer and those who have been instrumental in developing the radio telephone. The speaker referred at some length to the many fields of application of audiometry in the line of research and especially stressed the possibility of preventing deafenss by the periodic examination of school children in large groups to detect slight hearing loss. He mentioned the survey now being conducted by the committee of the American Federation of Organizations for the Hard of Hearing and pointed out the importance of the Diagnostic Ear Clinic in the public schools. He then demonstrated the use of the various audiometers manufactured by the Western Electric Company, and spoke of the work of Dr. Harvey Fletcher and his associates.

DISCUSSION.

DR. W. E. CAMP stated that he had had the pleasure of working with the various types of audiometers described by Dr. Newhart and that he was very much interested in this work. He said he had heard Dr. Fletcher's paper in Chicago and those members who were there and heard the discussion would recall that some of the men are still skeptical in regard to audiometry, but that it was certainly a step in the right direction. When one sees the ease with which the audiometer works and its diagnostic value in testing hearing and in helping diagnose different types of deafness, it is surprising that it has not been developed before. Dr. Camp stated that this who work with it can see that it still has some defects, which would doubtless be remedied as time goes on so that it will have much more value than at present.

Dr. Camp stated that the one thing he was skeptical about in the beginning was that bone conduction could not be eliminated; but he had found that to be a negligible factor except in cases of very marked deafness. It seemed to him that the chief benefit of the audiometer is found in diagnostic work. It brings out very clearly the cases of toxic auditory neuritis which were first described by Dean and Bunch. In their work they found a large number of cases of nerve deafness which were apparently due to focal infection. The audiometer shows very clearly the typical curve of nerve deafness.

In using the 3-A audiometer he had sometimes seen an inconsistency between the audiometer and other hearing tests, such as the watch and whisper, but he thought that this might be due to the fact that the other hearing tests are not developed to the same point of accuracy as the audiometer.

Dr. Camp stated that Dr. Newhart had made a very fine presentation and the members were all very grateful to have this brought before them.

DR. NEWHART, in closing, stated that in this school work it is important to educate the public to go back to the family physician for anything pertaining to the ears, with the expectation that he would direct such work as might be necessary. This should be made the rule, though he acknowledged the possibility that the family physician, not being in a position to confirm the result of the special tests, would at first not understand the importance of co-operation. A better understanding must be brought about in order to do this. It should be made clear to the school authorities that the diagnostic school clinic should not be established for therapeutic purposes but for diagnostic purposes only.

DR. W. E. CAMP, *Recorder.*

Meeting of March 12, 1926.

DR. D. L. TILDERQUIST, *Chairman.*

The regular monthly meeting of the Minnesota Academy of Ophthalmology and Otolaryngology was held in the library rooms of the Hennepin County Medical Society, Minneapolis, on Friday evening, March 12, 1926.

DR. KENNETH A. PHELPS reported three cases and showed X-ray films of each:

Case 1. The first case is that of a child age 2 years. He had pneumonia this winter and shortly after his recovery, his parents noticed that his neck was stiff. He carried his head on one side. This condition lasted three weeks before a physician was consulted. The physicians found no temperature, no tenderness along the spine, the head could be moved by force, there was no glandular enlargement, and the child swallowed his food easily, though his diet consisted of liquids. A pediatrician was consulted, who had an X-ray examination made of the child's neck. This showed a toy jackstone lodged in the esophagus at the level of the cricopharyngeus muscle.

So far as I know, torticollis is a new symptom of foreign body in the esophagus. I have been unable to find any reference to foreign body in the esophagus as a cause of wry neck.

After the removal of the jack, the torticollis promptly cleared up.

Case 2. The second case is a baby age 11 months. The mother saw the baby choke on something and put her finger in the child's throat at once. She removed a small bit of peanut "skin." Following this, there was a wheeze in the baby's chest, which was present all night. The next day she brought the baby to my office. The baby had no fever and seemed in perfect comfort. He breathed easily, had no cough, but the wheeze was present. The left chest showed limited expansion and the wheeze was heard louder over this lung. X-ray showed a condition which was diagnosed as collapse of the middle lobe. By means of the bronchoscope, a fair-sized piece of peanut was removed from the left bronchus in about two minutes. The baby had no reaction whatever from the operation.

Another X-ray was taken and the same condition was found as before, but at this time the radiologist made a diagnosis of an enlarged thymus, with an accessory lobe. Re-examination was made at one and three-week intervals, which confirmed the diagnosis of enlarged thymus.

Case 3. The third case is a baby, age 18 months, who was eating a candy bar containing almonds. He choked on a piece of it and became cyanotic, almost having a convulsion. The mother started for Minneapolis at once, and reached here two days later. She consulted a physician, who put the baby in the hospital for observation. He had an X-ray film made, which was reported "a normal chest." The child'es temperature was 103,° his breathing was noisy, he coughed frequently, was very restless and slightly cyanotic.

I saw the child one week after the accident occurred. At that time the right chest had poor expansion and no breath sounds could be heard over this lung. The bronchus was apparently occluded. X-ray showed a shadow over about one-half of the lung.

A very large piece of almond was removed from the right bronchus, which it completely obstructed. The bronchoscope was filled with thick, purulent secretion upon its removal. The bronchoscopy took three minutes.

The temperature dropped to normal that day and has been normal since. The chest cleared up promptly and the baby was quite well in a week.

Here are two nut cases. In the first, the peanut was removed within twenty-four hours. The baby had no inconvenience whatever. He had no temperature, no hoarseness and no difficulty in breathing.

In the second case, the nut was present one week and the child was very sick. He was cyanotic, restless, coughing and had a high temperature. The history was perfectly clear and definite, but on account of a negative X-ray report and physical signs not being pronounced, the child was allowed to wait.

These cases emphasize the fact that a bronchoscopy is indicated when the history is clear cut, even though the physical findings are not definite.

DR. WALTER E. CAMP, *Recorder.*

Meeting of April 9, 1926.

DR. D. L. TILDERQUIST, *Chairman.*

The regular monthly meeting of the Minnesota Academy of Ophthalmology and Otolaryngology was held in the library rooms of the Ramsey County Medical Society, Lowry building, St. Paul, on Friday evening, April 9, 1926, at 8 o'clock. Dr. D. L. Tilderquist, President, presided.

DR. K. C. WOLD presented two cases:

Case 1: Tumor of the antrum. S. R., age 36 years. The patient had had trouble in the right cheek for several years, following extraction of some teeth. Five months ago the dentist extracted some roots, and later an X-ray showed pieces of bone in the antrum.

Examination on March 12 showed the right antrum region greatly enlarged with alveolar processes ½ inch lower than the left side. The patient had an acute iritis. Puncture showed a small amount of pus. An X-ray was taken, which showed a large tumor mass in the right antrum. On March 22, when the iritis had subsided, the antrum was opened and a large fibrous tumor attached to the lower and nasal walls was removed. The surface was coagulated with diathermy.

Pathological report shows the tumor to be a solid odontoma. It was composed mainly of fibrous tissue and in the center were areas of bone formation simulating tooth pulp. Sections showed some areas of epithelial structure, but apparently not malignant.

Case 2: Acute mastoiditis and meningitis. J. P., girl, age 8 years, had had most of childhood diseases, including repeated attacks of tonsillitis.

The patient was first seen on March 2, when she had an acute tonsillitis and sinusitis, with a temperature of 104.° There was a slight pain in the right ear, but no objective signs of otitis media.

On March 4, two days later, the pain persisted in the ear; there was slight bulging of the drum and tenderness in the mastoid region, but no other signs. Myringotomy was performed and blood and serum found in the middle ear. The next day the temperature had dropped; but quite suddenly in the afternoon the patient developed nystagmus, positive Kernig and rigidity of the neck. At the hospital an X-ray was taken showing a cloudy mastoid, with absence of septa. Spinal puncture showed cloudy fluid under increased pressure and a cell count of 150. Thirty c.c. of antimeningococcic serum was given and the patient came out of stupor with marked reduction of meningeal symptoms. Twenty-four hours later this procedure was repeated, the spinal fluid showing a cell count of 1000.

At this time, because of definite improvement in meningeal symptoms and very evident signs of active mastoid involvement, a mastoid operation was performed. The cells were broken down and necrotic up to and including the antrum and inner table. The dura over the middle fossa was exposed and showed grayish exudate over an area the size of a dime. Following the operation the patient made an uneventful convalescence, and at present shows no permanent impairment of any kind.

This case probably comes under the classification of circumscribed aseptic meningitis, with the mastoid as the source of infection. Streptococcus was found in the mastoid cavity, but no organisms were found in the spinal fluid.

DISCUSSION.

DR. CARL LARSEN stated that the case Dr. Wold reported was exceedingly interesting, and it was difficult to know just what to do under the circumstances which the case presented. The spinal fluid was cloudy and under pressure, the patient had Kernig and was in a stupor, with high temperature and pulse. One would hardly attribute all of these symptoms to merely a cortical or subcortical irritation. The dura also showed a circumscribed area covered with granulation tissue.

In view of the outcome of the case, Dr. Larsen thought one would be obliged to classify it as a probable circumscribed aseptic meningitis. He had seen two such cases within the past year, both of which recovered.

DR. W. E. CAMP, *Recorder.*

BOOK REVIEWS

Diseases of the Nose and Throat, Comprising Affections of the Trachea and Esophagus. A textbook for Students and Practitioners. By Sir St. Clair Thomson, M. D., F. R. C. P., London; F. R. C. S., England, etc. Third edition, with twelve black-and-white plates and three hundred seventy-nine figures in the text. London: Cassell and Company, Ltd., 1926. Price $12.90 including $1.64 duty and postage.

Quoting from the author's preface to the third edition: "I am somewhat gratified to find that the foundations of the work were so well and truly laid in 1911 that there has been no need to tamper with them and the scheme of it remains the same after fifteen years." There is no greater satisfaction to any author who contemplates the revision of an important treatise in Science than to realize a conclusion as expressed in this thought. Those of us who have closely followed the evolution of modern Rhinology and Laryngology in the past two decades concur in this opinion that a well laid foundation in the construction of a textbook, such as the one presented by our esteemed and able British confrere, needs no reconstruction but simply a revision to keep pace with the progress of the Special Medical Sciences. New sections have been written on Malignant Granuloma of the Nose, Dental and Dentigerous Cysts, Dermoid Polypi of the Naso-Pharynx, Chorditis Fibrinosa and Leukoplakia Laryngis.

The chapter, Esophagectasia, has taken the place of Dilatation of the Esophagus, and the sections on Cicatricial Stenosis of the Esophagus and of the Larynx have been rewritten, and the chapter on Operations has been revised.

Radium, X-ray Therapy and Diathermy have received consideration; new illustrations have replaced some of the older ones, especially Radiograms. The twelve color plates appearing in this edition are of fine artistic value and natural color and the entire typography is of the best quality.

The third edition as now presented constitutes one of the finest textbooks in Rhinology and Laryngology produced by a British confrere.

M. A. G.

Cavernous Sinus Thrombophlebitis and Allied Septic and Traumatic Lesions of the Basal Venous Sinuses. A clinical study of Blood Stream Infection. By Wells P. Eagleton, M. D., Medical Director Newark Eye and Ear Infirmary, Newark, N. J.; Chief of the Division of Head Surgery, Newark City Hospital, etc. New York: The Macmillan Company. 1926.

The author modestly calls this authoritative volume a monograph. The gery and his extensive experience in the intimate study of twenty-five personally observed cases of Cavernous Sinus Thrombophlebitis, and the minute clinical and laboratory investigations and observations that have been made of these cases justifies us in its consideration as a substantial treatise of this all-important field of special surgery.

There is also to be considered his intimate experience with Thrombophlebitis of the Jugular Bulb, Infective Orbital Thrombophlebitis, Arteriovenous Aneurism of the Cavernous Sinus and Longitudinal Sinus Thrombosis. All of these rather infrequent pathological conditions and their separate consideration add to the importance of this treatise.

Every page bears the evidence of independent thought, long experience and good judgment in the consideration and disposal of these groups of unusual otologic pathologies.

M. A. G.